

PREGNANCY & STROKE



DIOGO C. HAUSSEN, MD

Assistant Professor in Neurology, Neurosurgery, and Radiology



**MARCUS STROKE &
NEUROSCIENCE CENTER**



DISCLOSURES:

Stryker Neurovascular / Concentric Medical

- DAWN Trial Site PI
- SELECT Study Site PI
- Consultant

Medtronic / Covidien / ev3 Neurovascular

- STRATIS registry Site PI

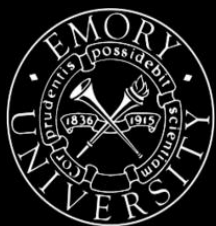
Codman / Johnson & Johnson

- Consultant (unpaid)

Vesalio

DIOGO C. HAUSSEN, MD

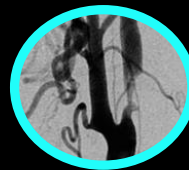
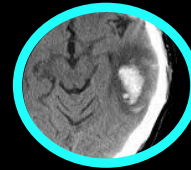
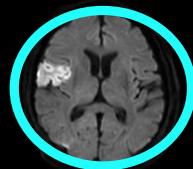
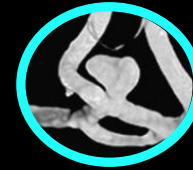
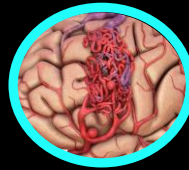
Assistant Professor in Neurology, Neurosurgery, and Radiology



**MARCUS STROKE &
NEUROSCIENCE CENTER**



“STROKE”



STROKE AND PREGNANCY

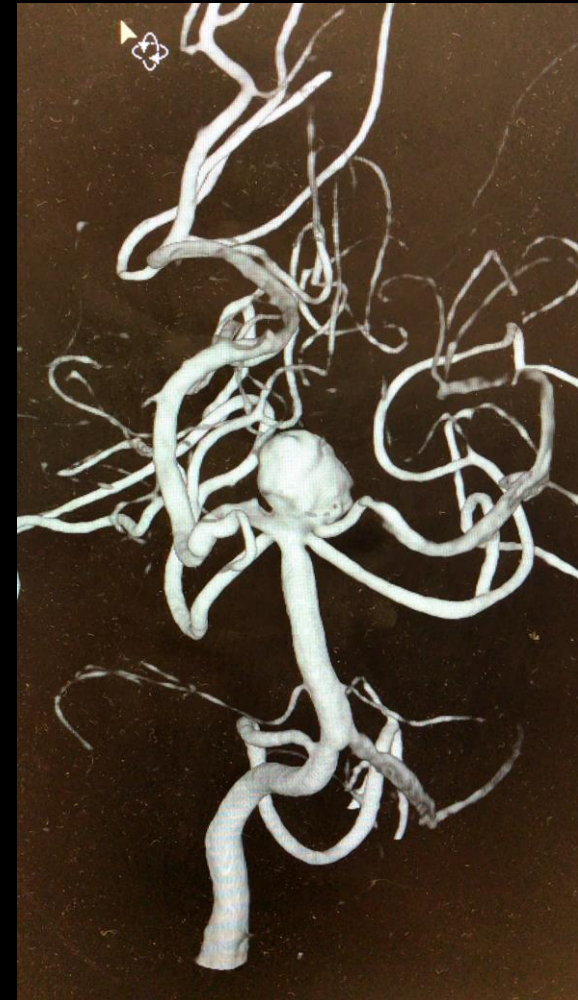
- US: incidence of stroke in pregnancy is increasing.
 - Nationwide Inpatient Sample
 - Between 1994–1995 to 2006–2007,
 - Rates of antenatal and postpartum hospitalizations for stroke increased by 47% and 83%, respectively.

Kuklina et al. 2011

- Rate of stroke: 25–34 cases per 100,000 deliveries
- While stroke in non-pregnant woman aged 15–44 years of age is 11 per 100,000 women
- Small percentage of pregnant women are diagnosed with stroke, BUT accounts for 12% of maternal deaths and contributes to significant fetal morbidity and mortality.

Aneurysm

- **Definition:**
 - Acquired lesions of the major arteries.
 - Commonly at branching points
- **Mechanism:**
 - Hemodynamic stress
 - Inflammation
 - Genetic predisposition
- **Prevalence:**
 - 3.2% in adults
- **Age:**
 - Peak 60-79yo



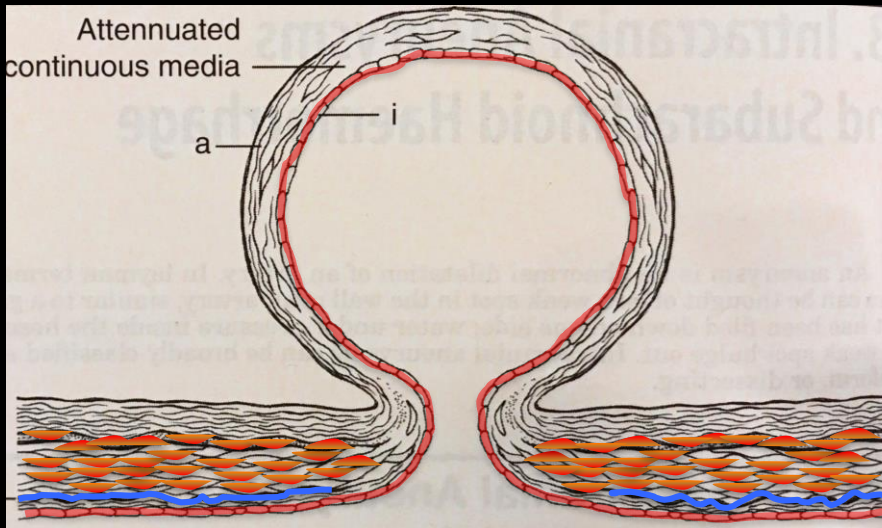
Hashimoto et al. Neur Res 2006;28
Theodotou CB. Asian J Neuros 2017; 12
Krings et al. Neuroradiology 2004;47
Vlak M. Lancet Neurology 2011;10
Rinkel G. Stroke 1998; 29

Microscopy

- **Histopathology:**
 - Intracranial arteries: No Elastica Externa
 - Discontinuation of media and internal elastica
 - More frequently acellular

Kondo et al. Stroke. 1997;28

Harrigan M, Deveikis J. 2nd Edition. Springer. 2013



Why Are We Discussing Aneurysms?



Why Are We Discussing Aneurysms?

Aneurysms

PREGNANCY

- Plasma volume
 - Increases by 50%
 - Plateau at 30-34w

POSTPARTUM

- Body prepared for event (birth) that requires rapid coagulation
- Coagulation activated / fibrinogen increased
- Coagulation inhibitors decreased

Aneurysms During Pregnancy

- SAH: pregnant 5x of nonpregnant (of same age).
- 0.01-0.05% of all pregnancies
- Risk of rupture increases as gestation progresses (peak 30-34w)
- Valid to treat the aneurysm prior to pregnancy

Aneurysm Treatment: Surgery

Advantages:

Duration

Hematoma Evacuation

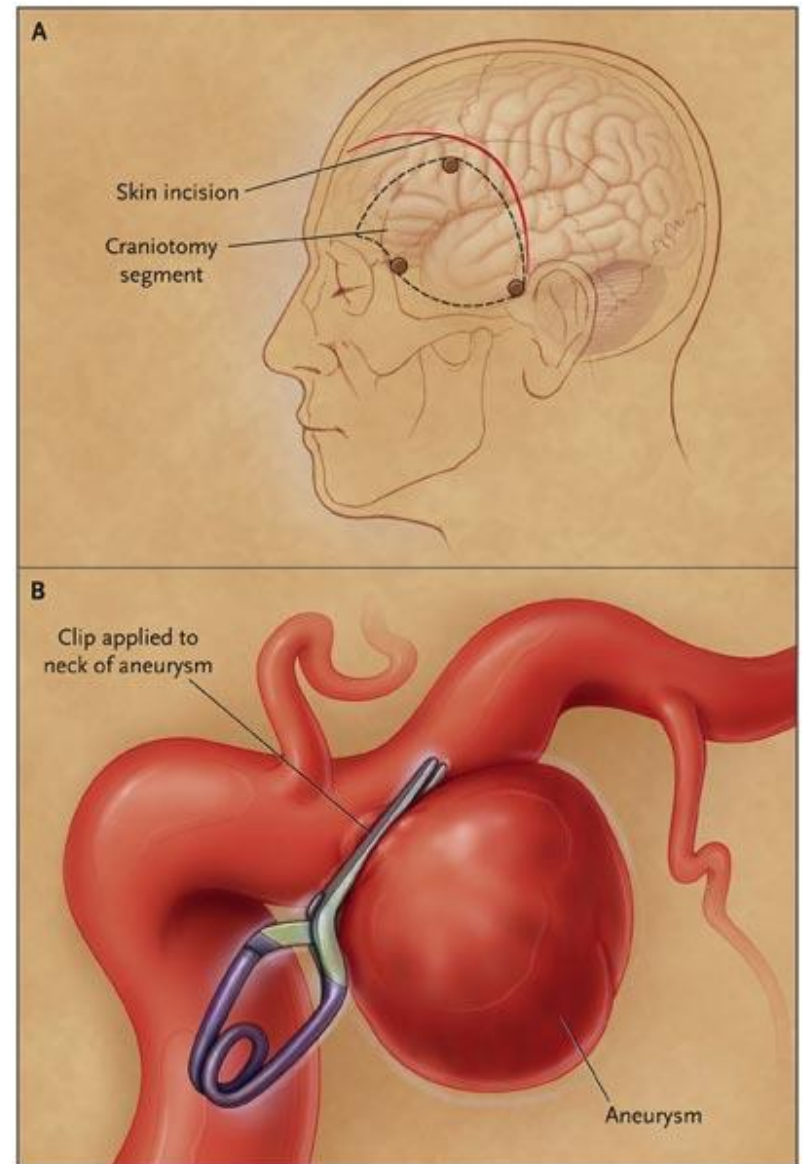
Disadvantages:

Invasive

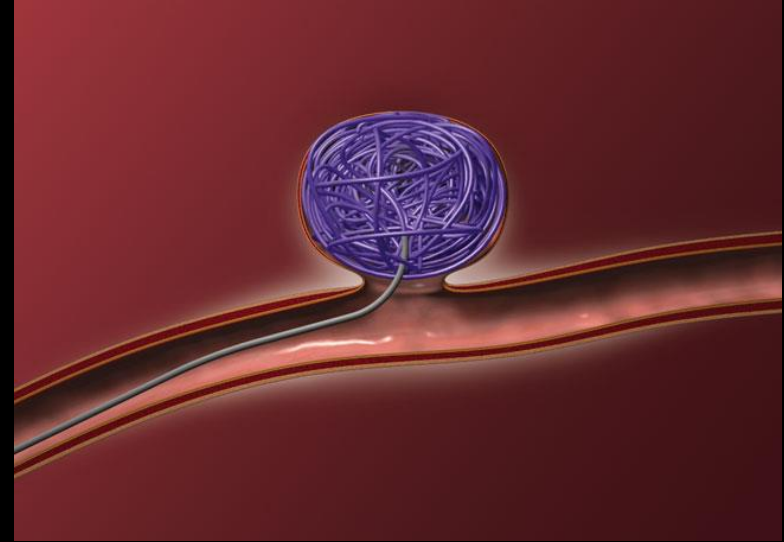
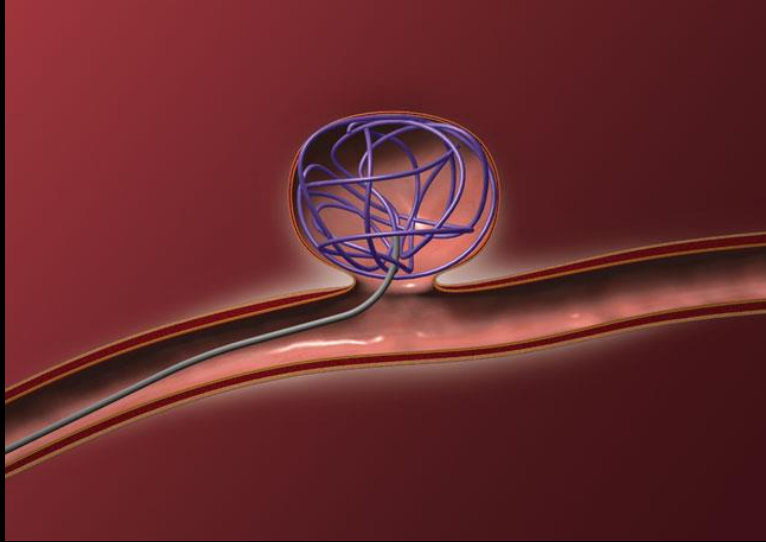
Retraction Injury

Perforating vessels

Seizures



Aneurysm Treatment: Endovascular Coiling

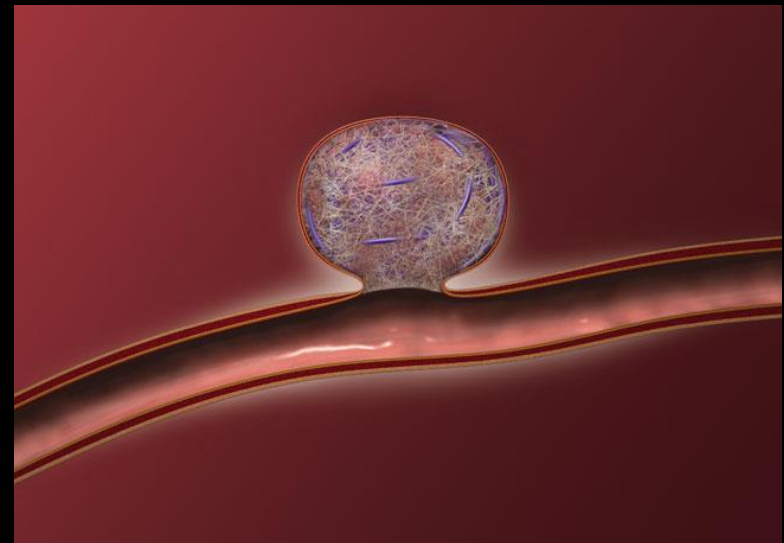


Advantages:

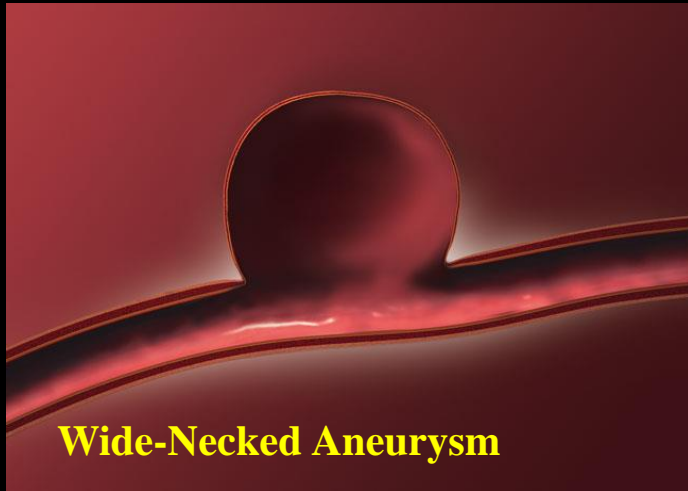
Less invasive

Disadvantages:

Coil compaction with need for retreatment



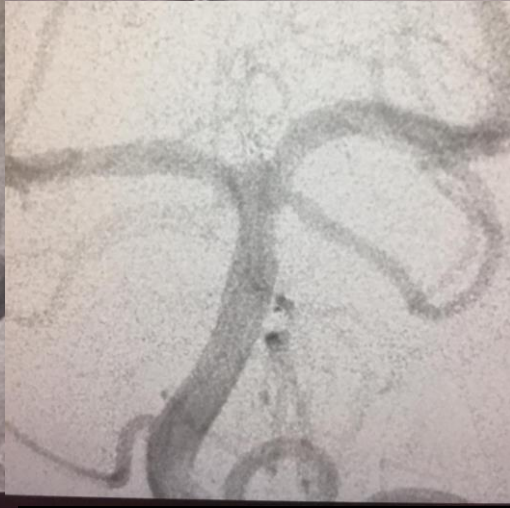
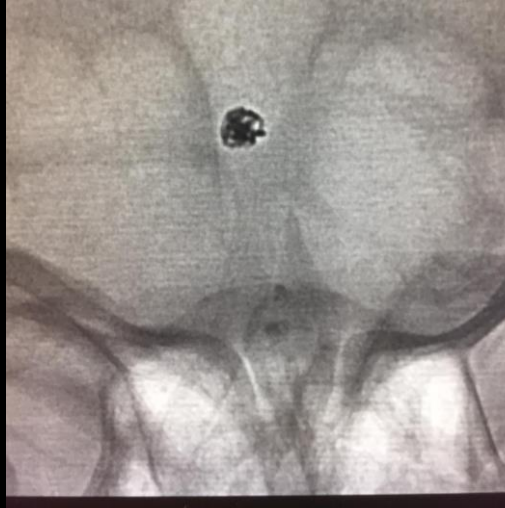
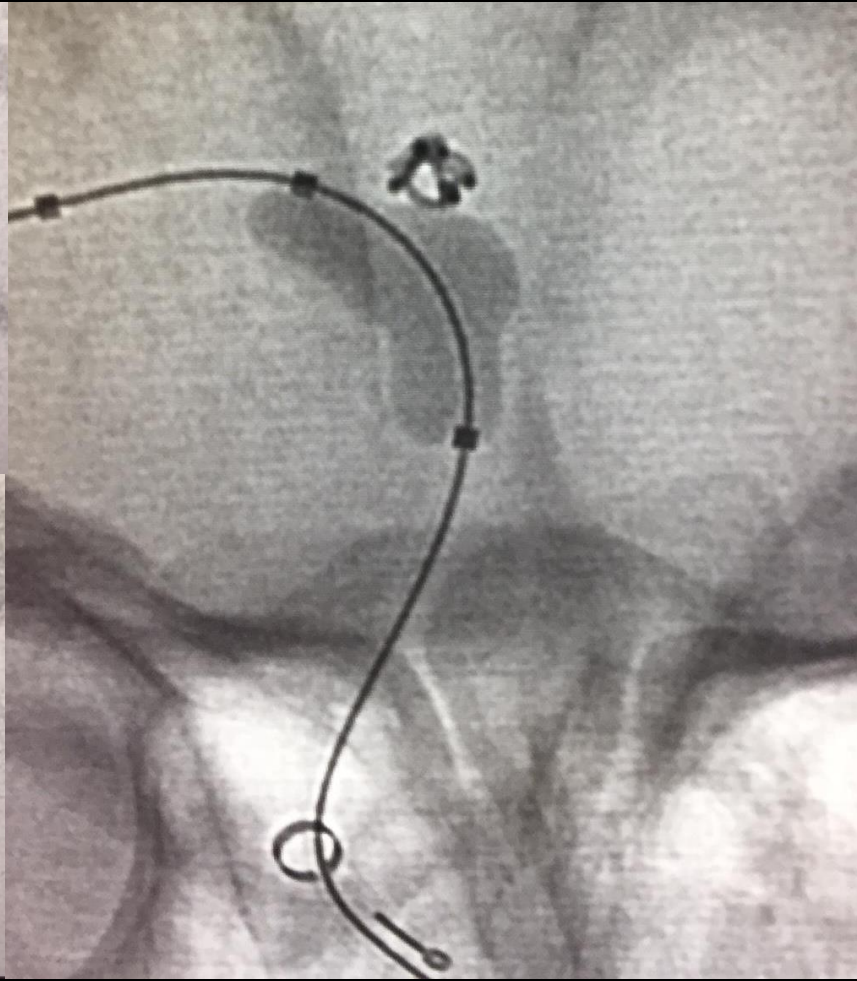
Wide-Necked Aneurysms



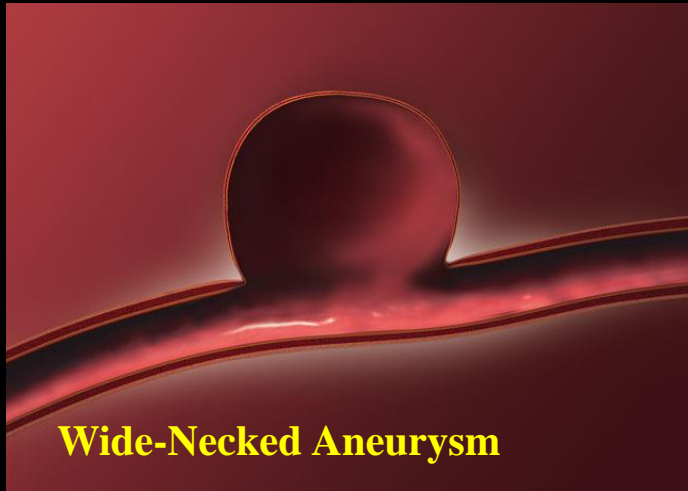
Wide-Necked Aneurysm:

- Neck > 4 mm
- Dome: Neck Ratio $< 2:1$

Balloon Remodeling



Wide-Necked Aneurysms

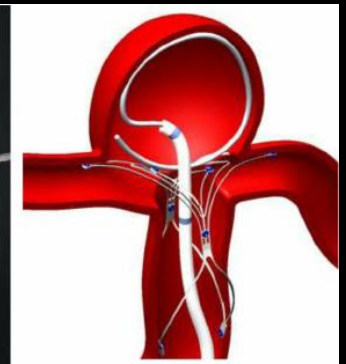
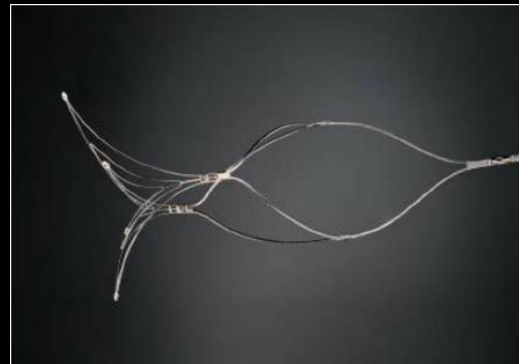
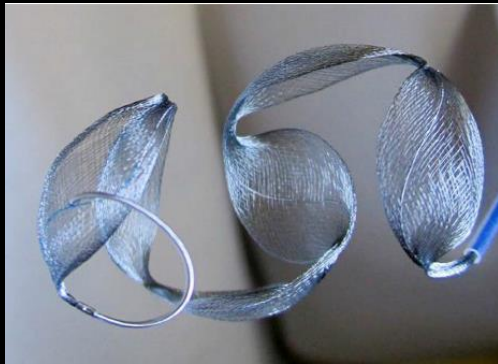


Wide-Necked Aneurysm:

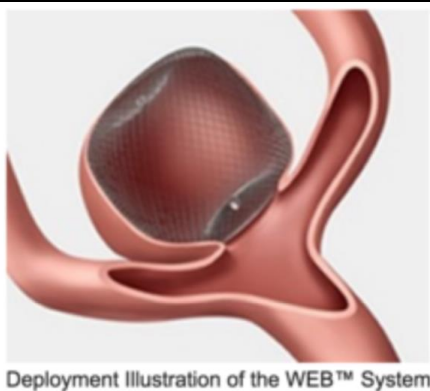
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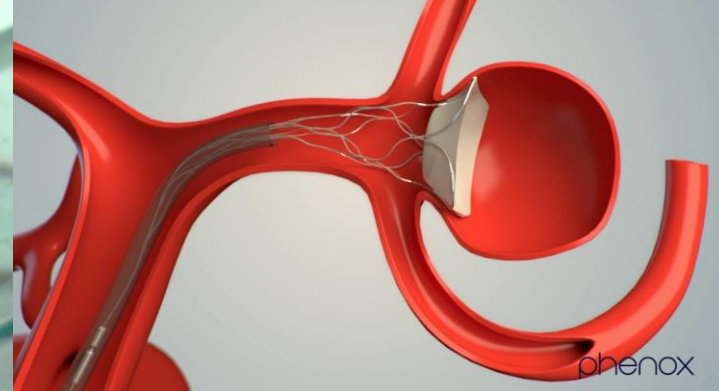
NEW TECHNOLOGIES



The WEB™ Aneurysm Embolization Device



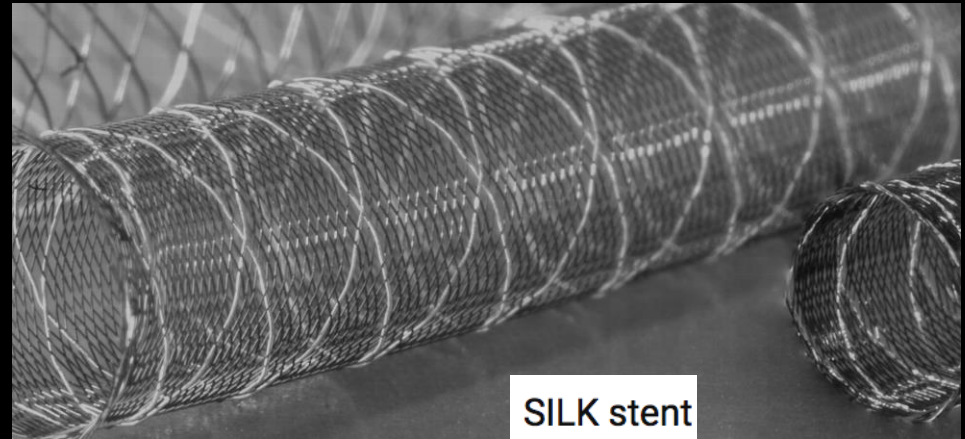
Deployment Illustration of the WEB™ System



phenox

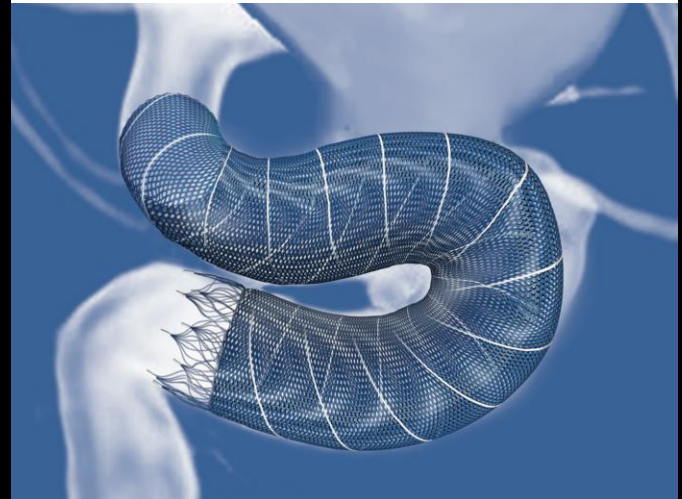
FLOW DIVERGING STENTS

Surpass Streamline



SILK stent

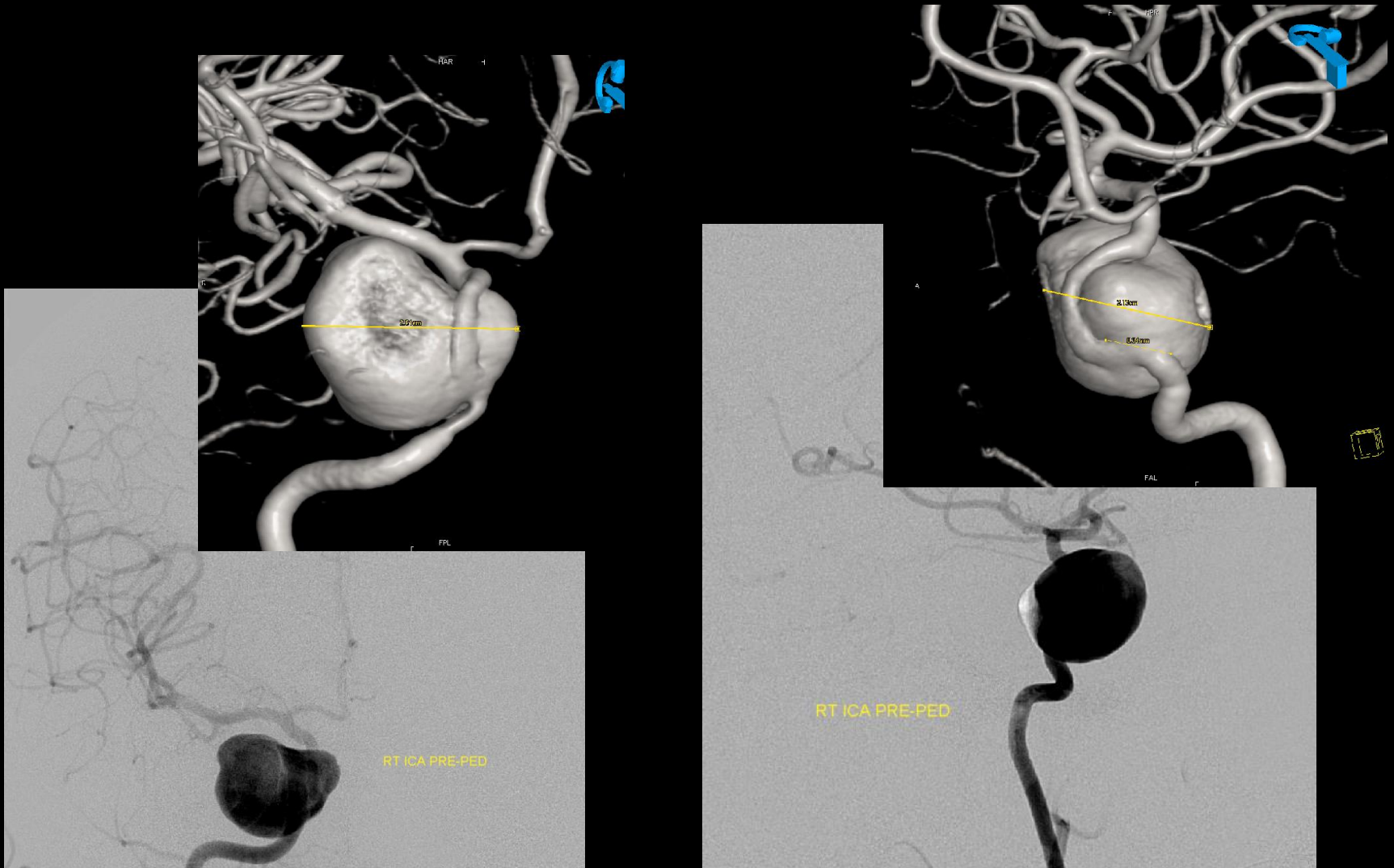
p64 Flow Modulation Device

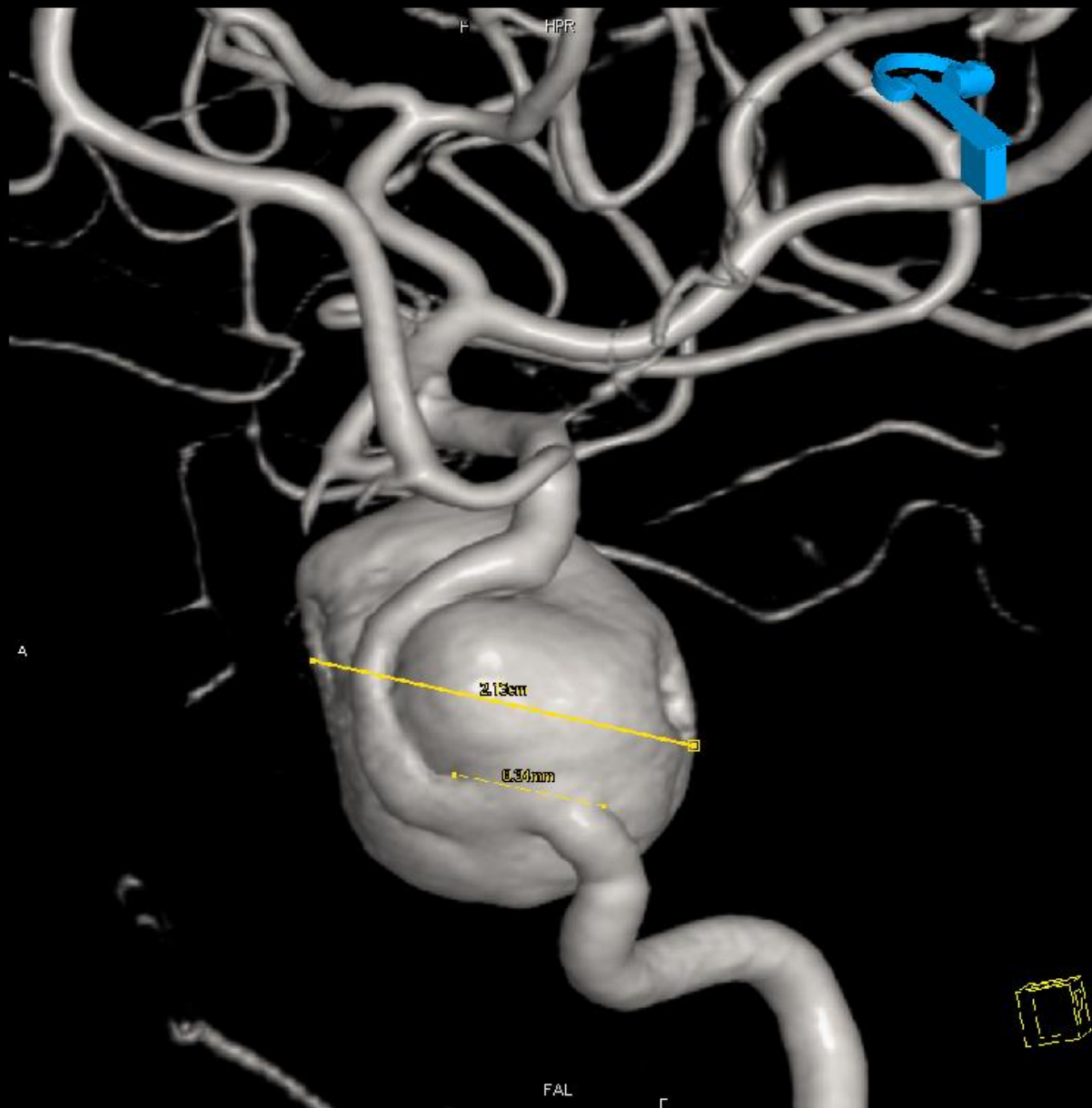


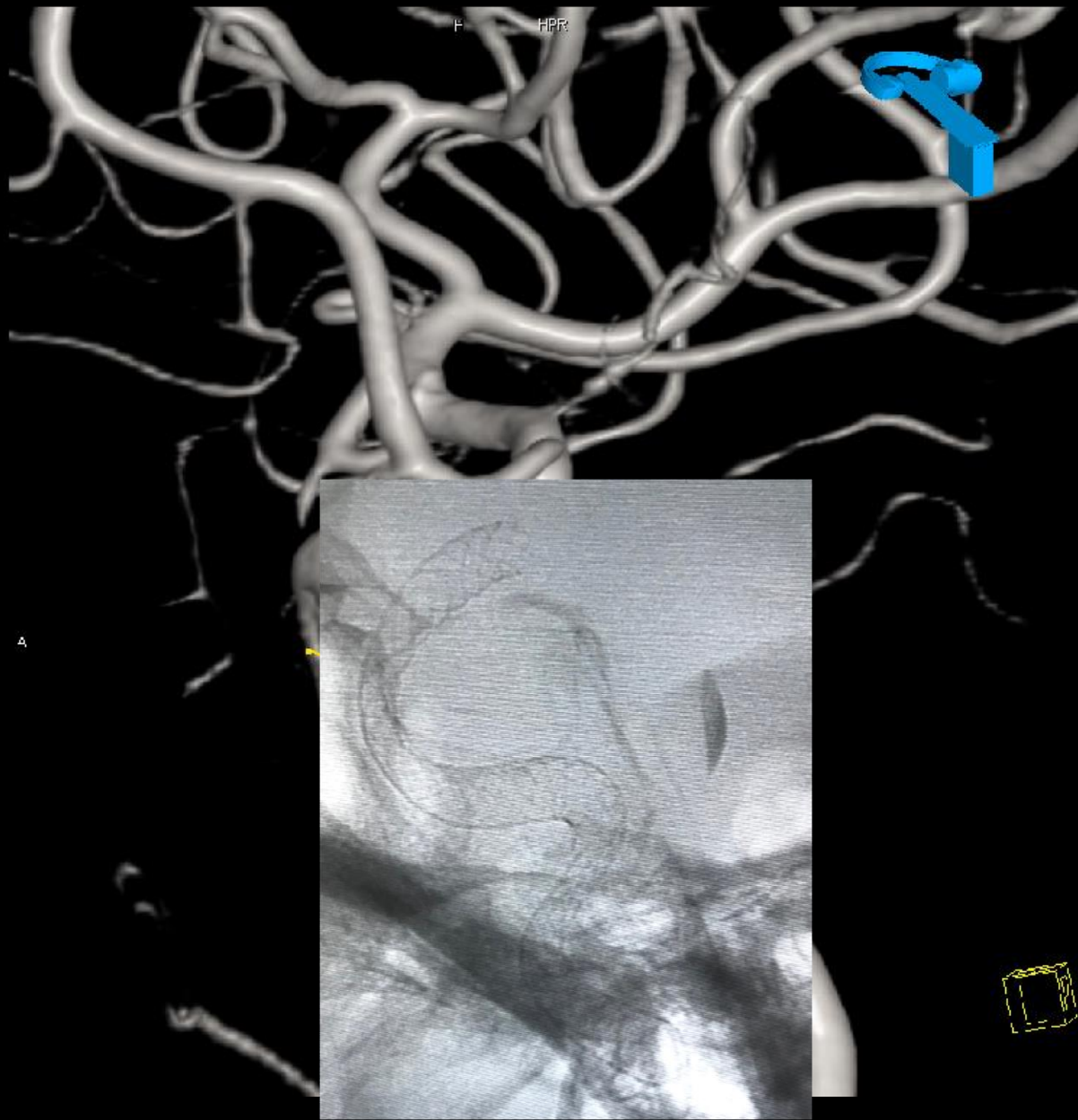
How does the PED Work?

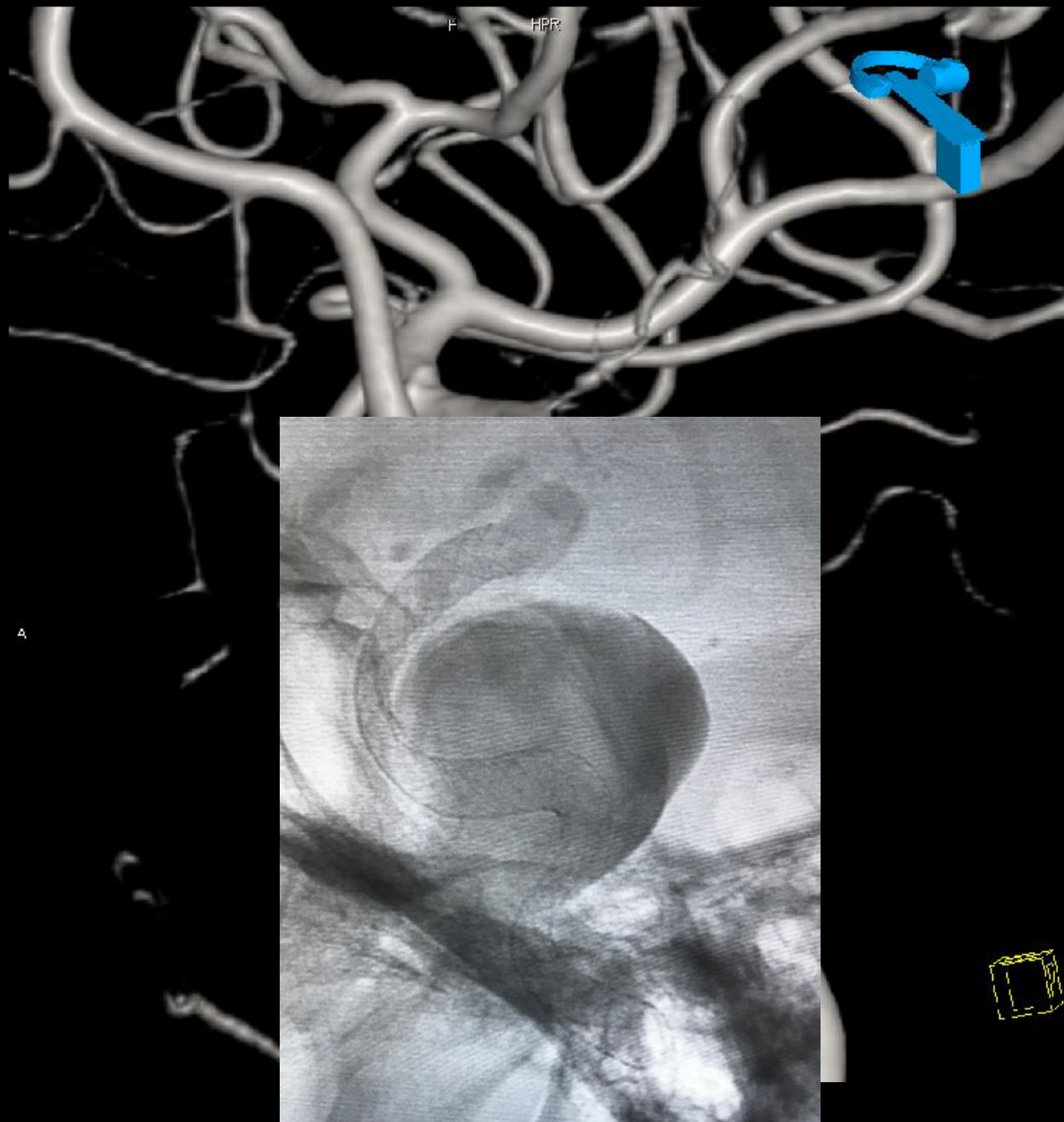


Case Example – Pre Treatment







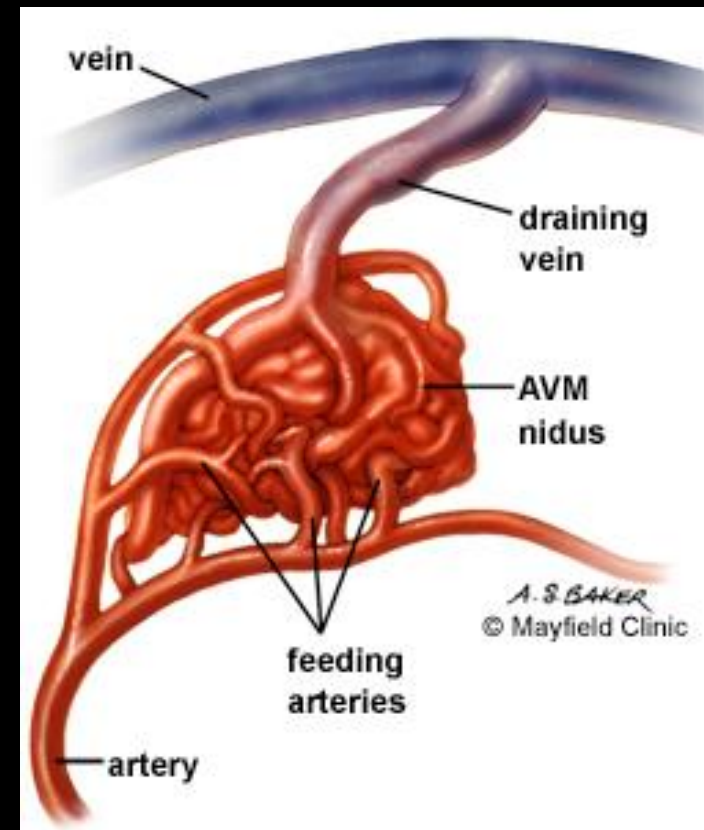


Case Example – Follow-Up



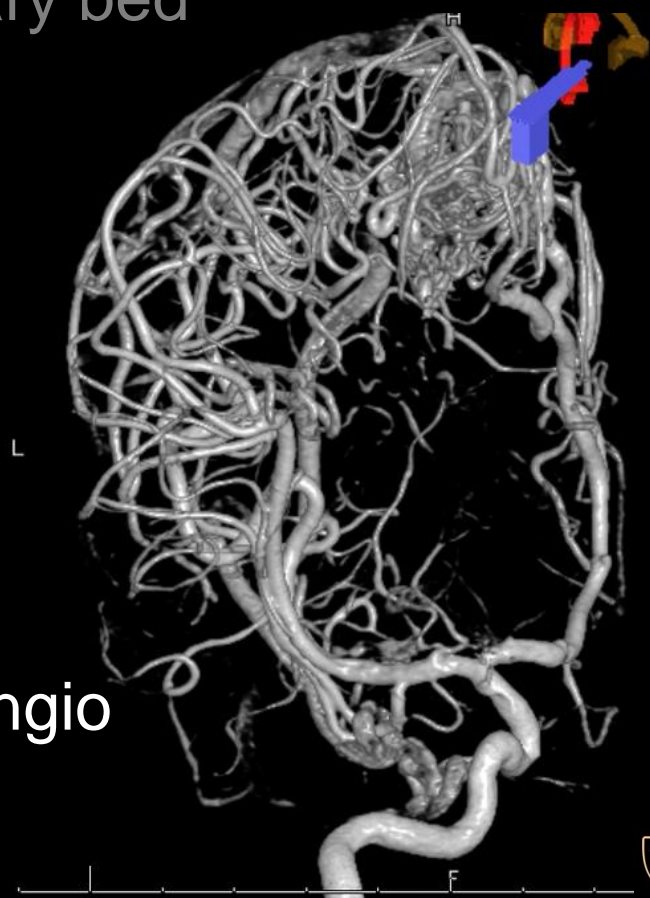
ARTERIOVENOUS MALFORMATION

- Congenital vascular lesion
- Direct connection between arteries and veins without intervening capillary bed
- 0.005-0.6% of population
- Men 55%
- Presentation:
 - Hemorrhage
 - Seizures
 - Headaches



ARTERIOVENOUS MALFORMATION

- Congenital vascular lesion
- Direct connection between arteries and veins without intervening capillary bed
- 0.005-0.6%
- Men 55%
- Presentation:
 - Hemorrhage
 - Seizures
 - Headaches
- Diagnosis: NCCT, MRI, Angio

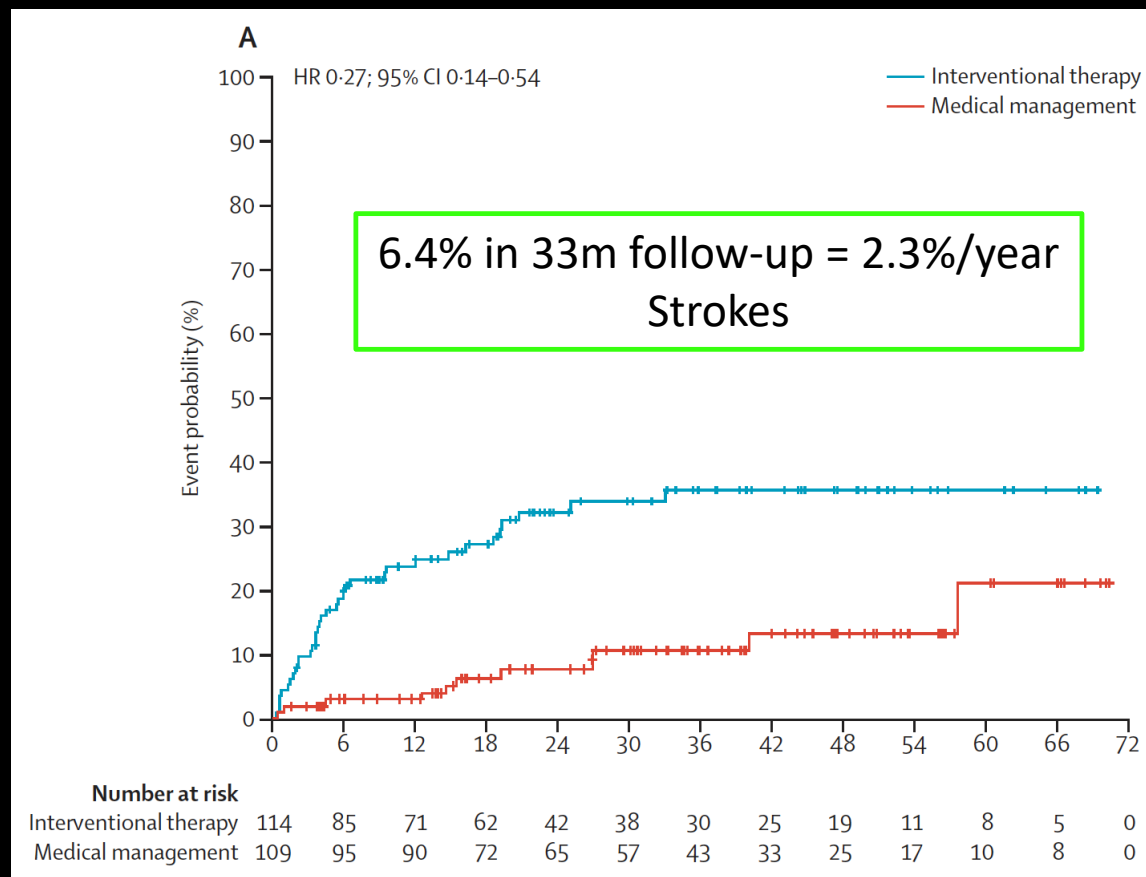


SHADE/SURF

LAO/RAO -170
CRAN/CAUD (

Medical management with or without interventional therapy for unruptured brain arteriovenous malformations (ARUBA): a multicentre, non-blinded, randomised trial

J P Mohr, Michael K Parides*, Christian Stapf*, Ellen Moquete, Claudia S Moy, Jessica R Overbey, Rustam Al-Shahi Salman, Eric Vicaut, William L Young†, Emmanuel Houdart, Charlotte Cordonnier, Marco A Stefani, Andreas Hartmann, Rüdiger von Kummer, Alessandra Biondi, Joachim Berkefeld, Catharina J M Klijn, Kirsty Harkness, Richard Libman, Xavier Barreau, Alan J Moskowitz, for the international ARUBA investigators‡*



ARTERIOVENOUS MALFORMATION

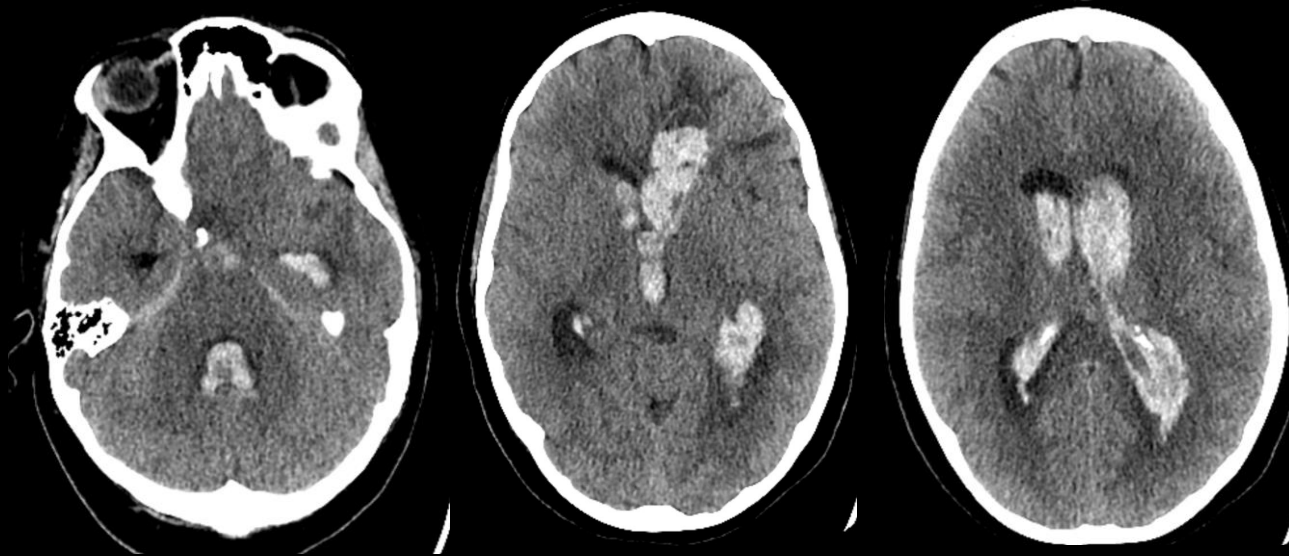
- 27yo developed headaches during pregnancy
- First pregnancy; 26 weeks



Last

ARTERIOVENOUS MALFORMATION

- 32 weeks
- Acute neurological deterioration
- GCS 11 / NIHSS 15



ARTERIOVENOUS MALFORMATION



ARTERIOVENOUS MALFORMATION



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Zoo

ARTERIOVENOUS MALFORMATION



ARTERIOVENOUS MALFORMATION



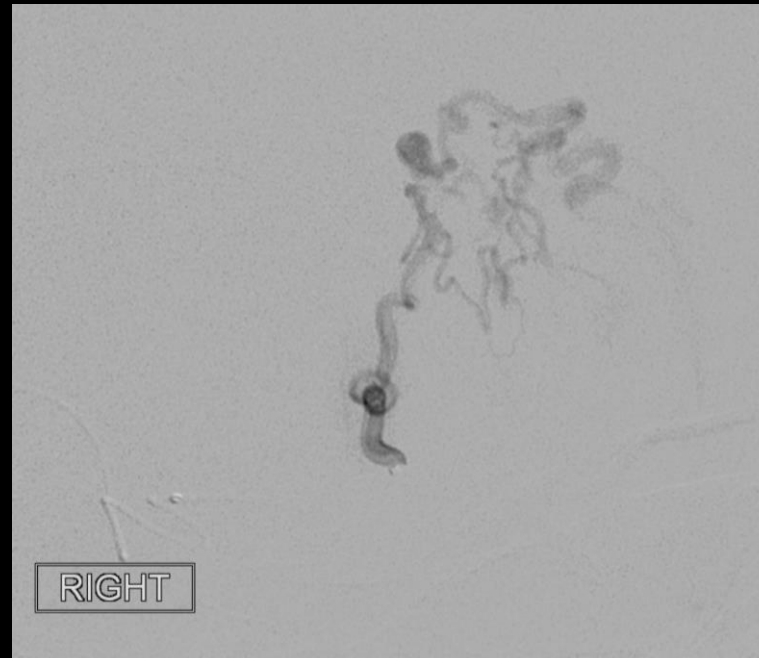
ARTERIOVENOUS MALFORMATION



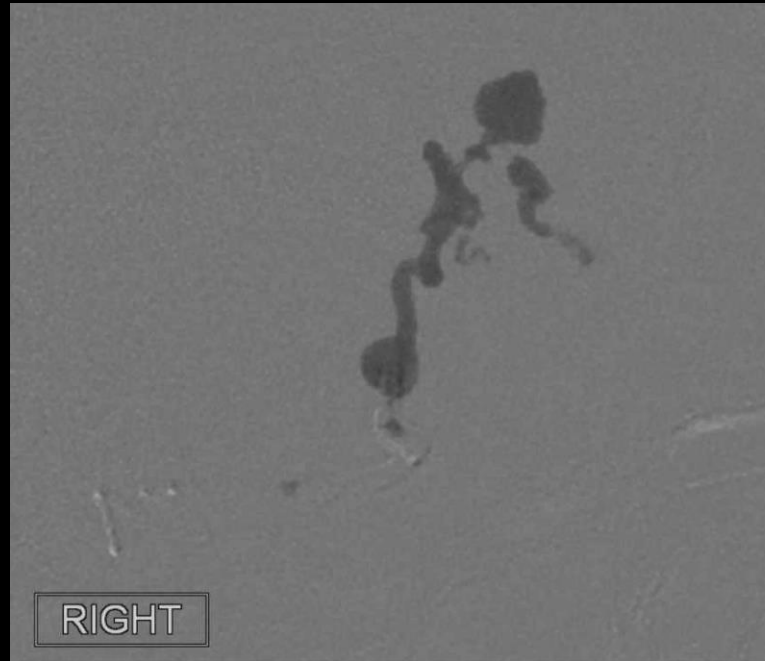
ARTERIOVENOUS MALFORMATION



ARTERIOVENOUS MALFORMATION



ARTERIOV



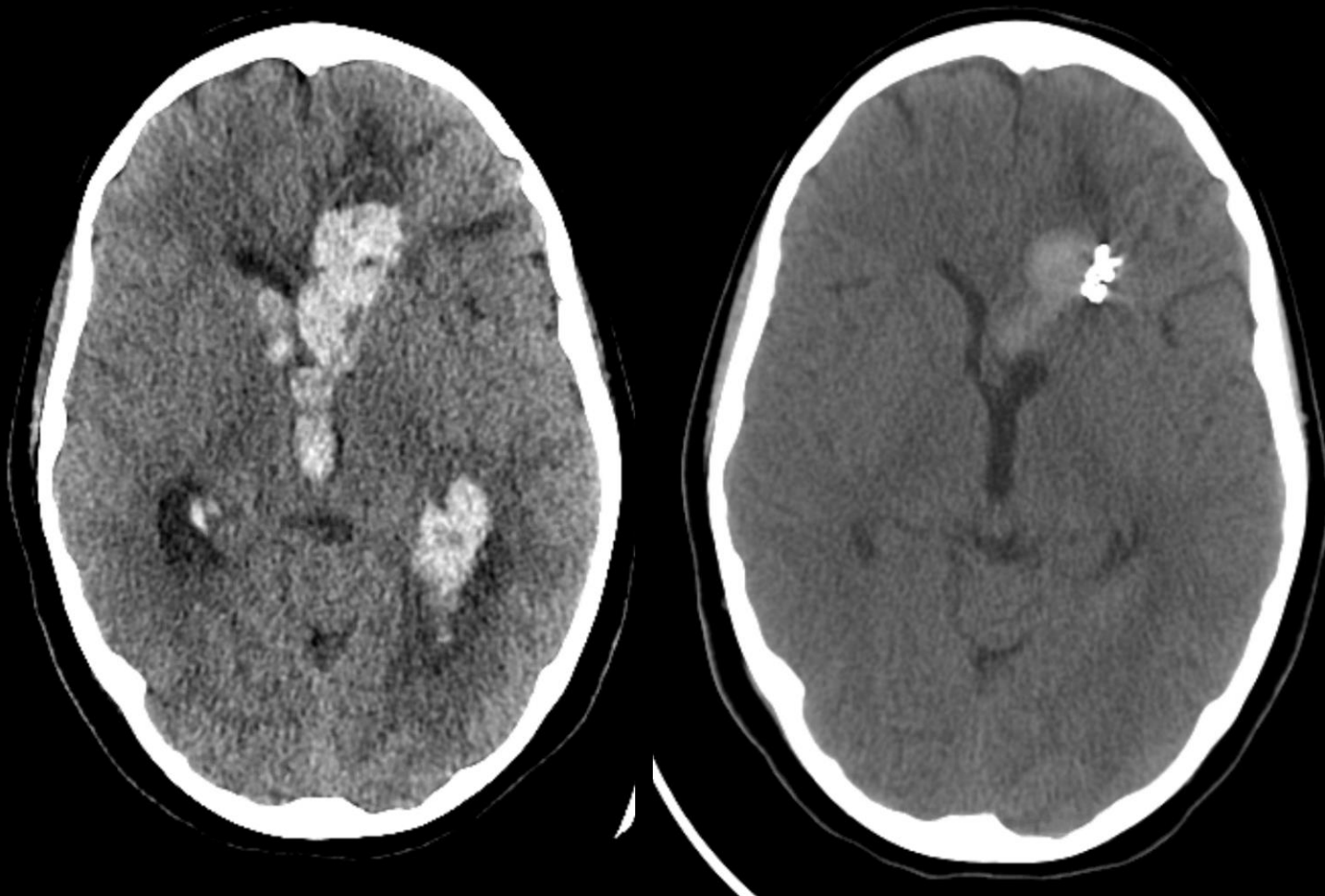
ARTERIOVENOUS MALFORMATION



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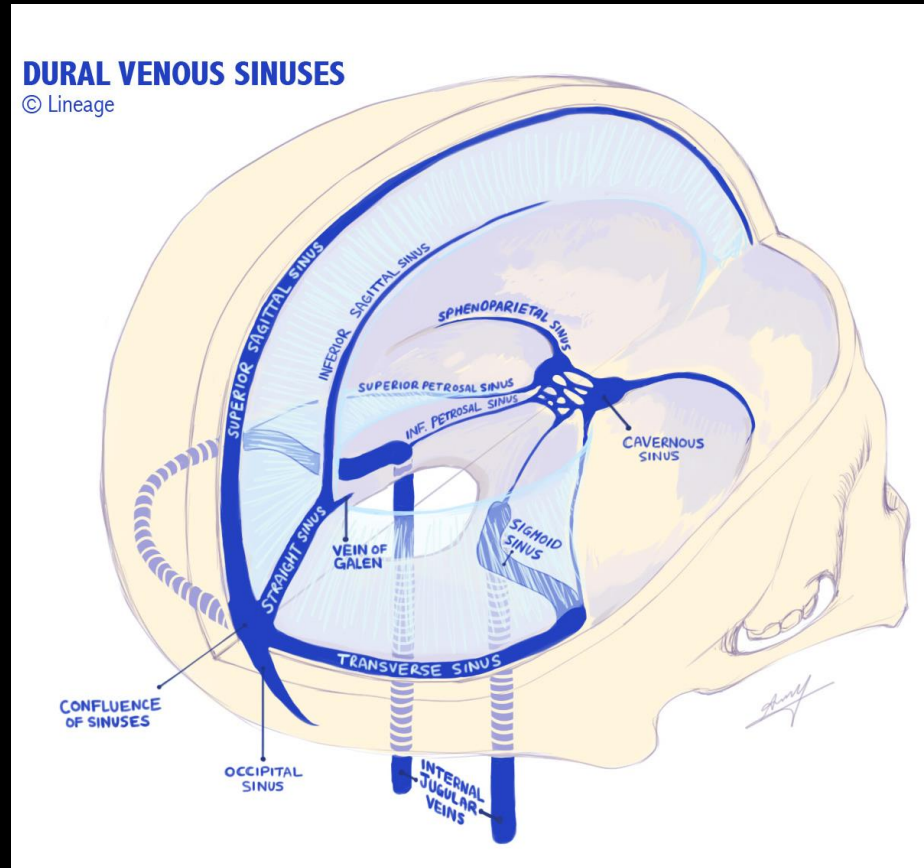


ARTERIOVENOUS MALFORMATION



CEREBRAL VENOUS THROMBOSIS

- 0.5-1% of all strokes
- Stasis of the blood, changes in the vessel wall, changes in the blood composition.
- Clotting of the venous sinuses



CEREBRAL VENOUS THROMBOSIS

- Prior medical conditions
 - eg, thrombophilias, inflammatory bowel disease
- Transient situations
 - eg, pregnancy, dehydration, infection
- Selected medications
 - eg, oral contraceptives, substance abuse)
- Unpredictable events
 - eg, head trauma)

CEREBRAL VENOUS THROMBOSIS

Pregnancy and Puerperium

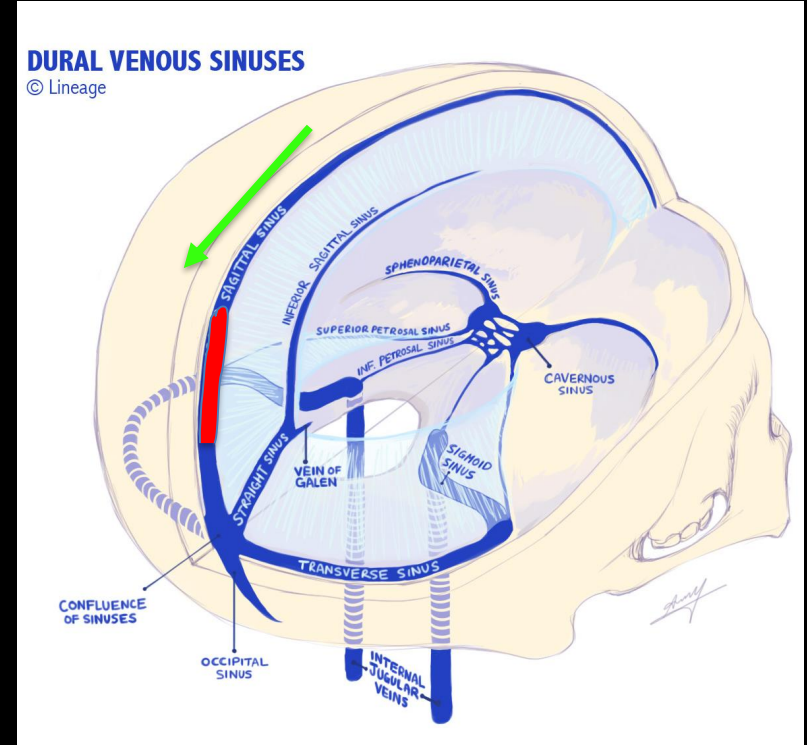
- Causes of transient prothrombotic states.
- Approximately 2% of pregnancy-associated strokes are attributable to CVT.
- 50% of CVT occur during pregnancy (most in 3rd trimester) or puerperium (6-8w / 80%).

Oral Contraceptives

- 96% of CVT cases were using oral contraceptives

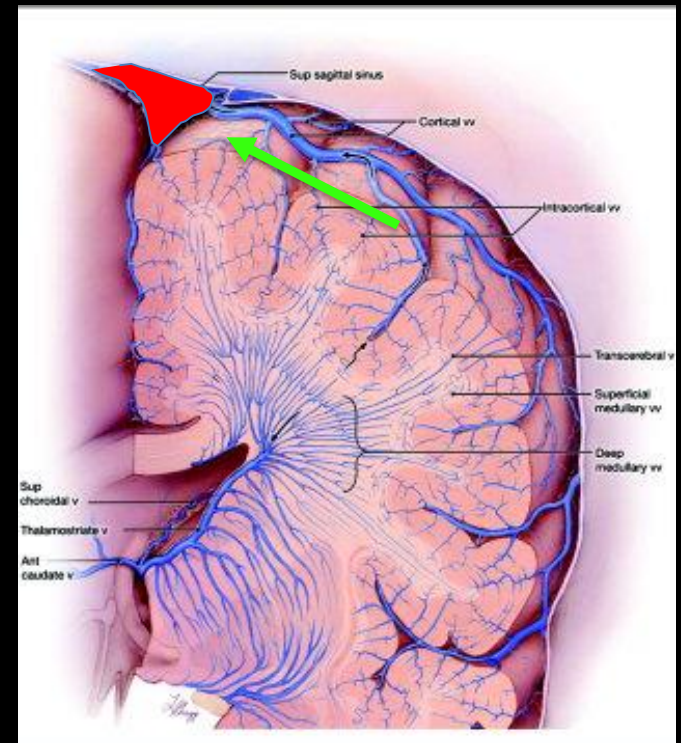
CEREBRAL VENOUS THROMBOSIS

- Diagnostic Challenge
- Increased intracranial pressure
- Headaches (90%)
- Seizures
- Focal neurology changes
- Hemorrhages



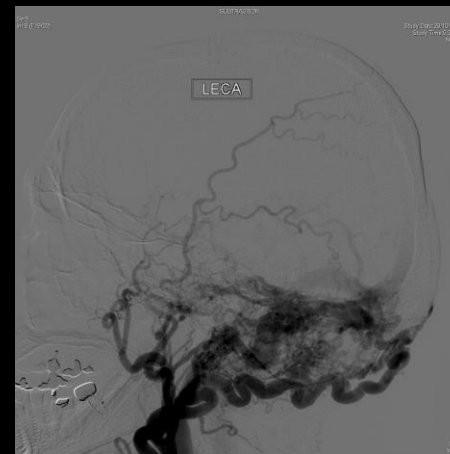
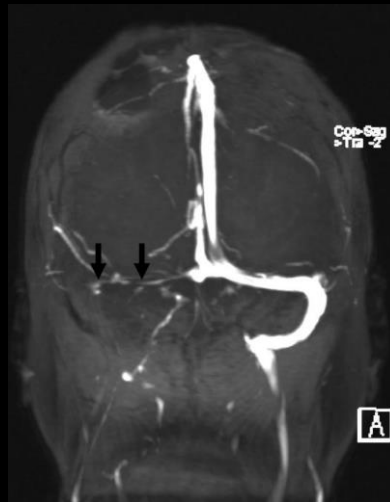
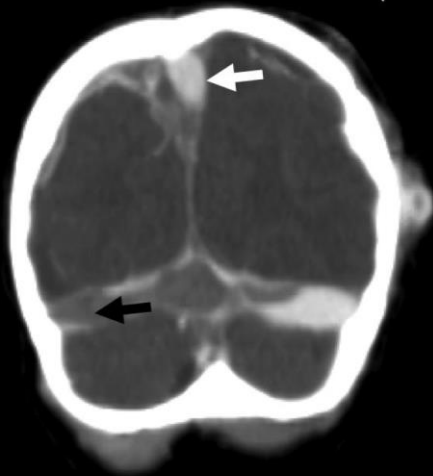
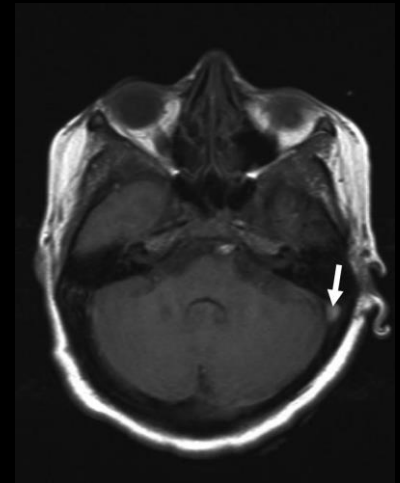
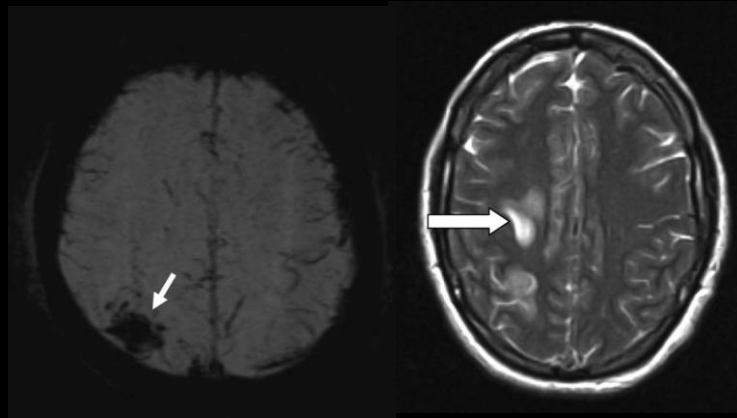
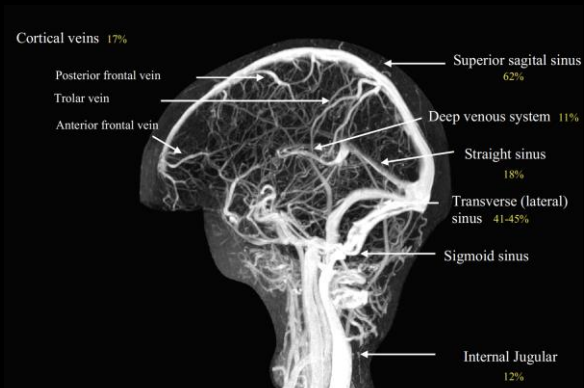
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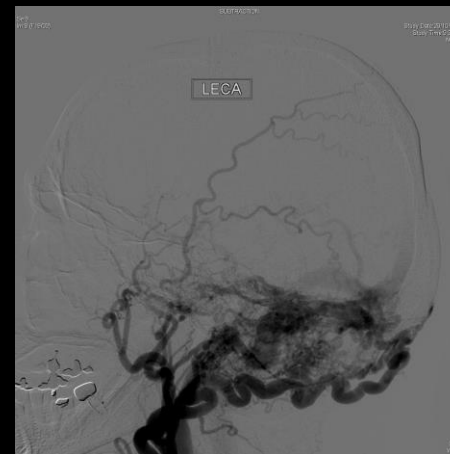
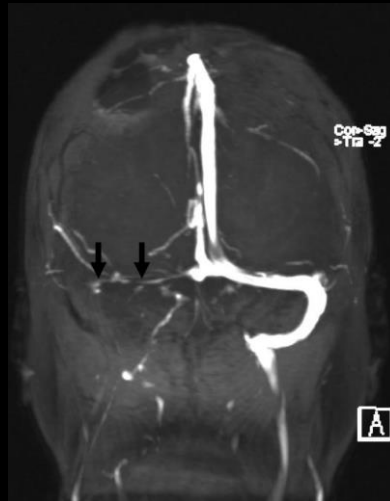
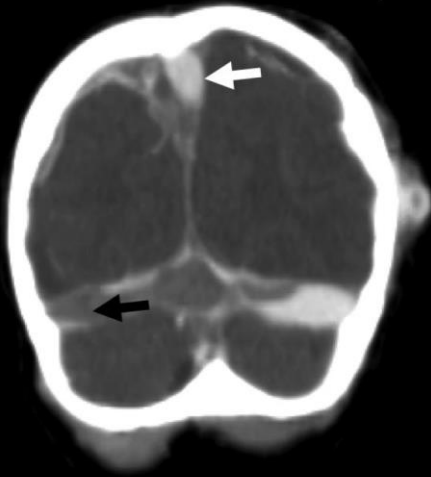
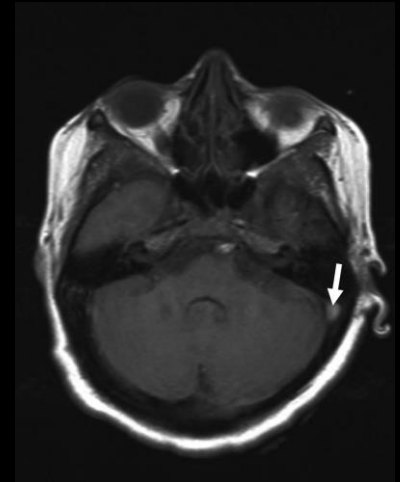
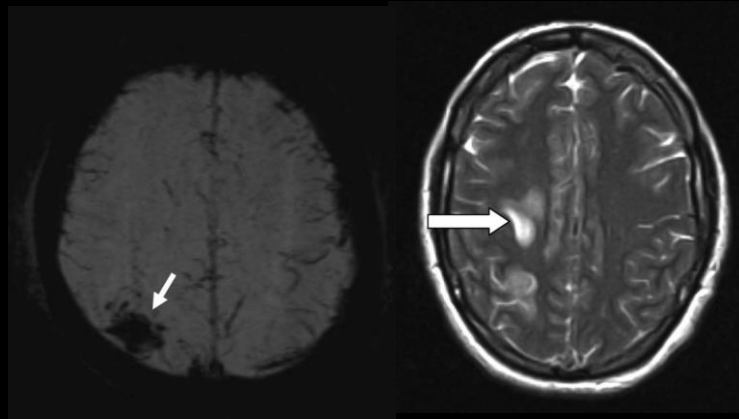
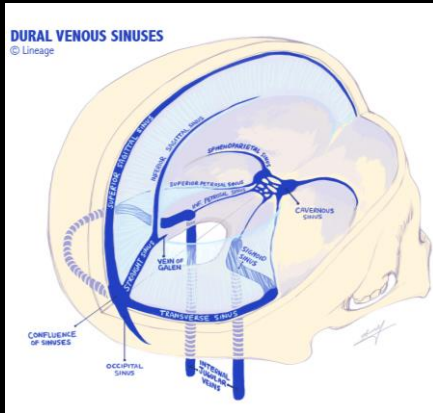
CEREBRAL VENOUS THROMBOSIS

- IMAGING



CEREBRAL VENOUS THROMBOSIS

- IMAGING



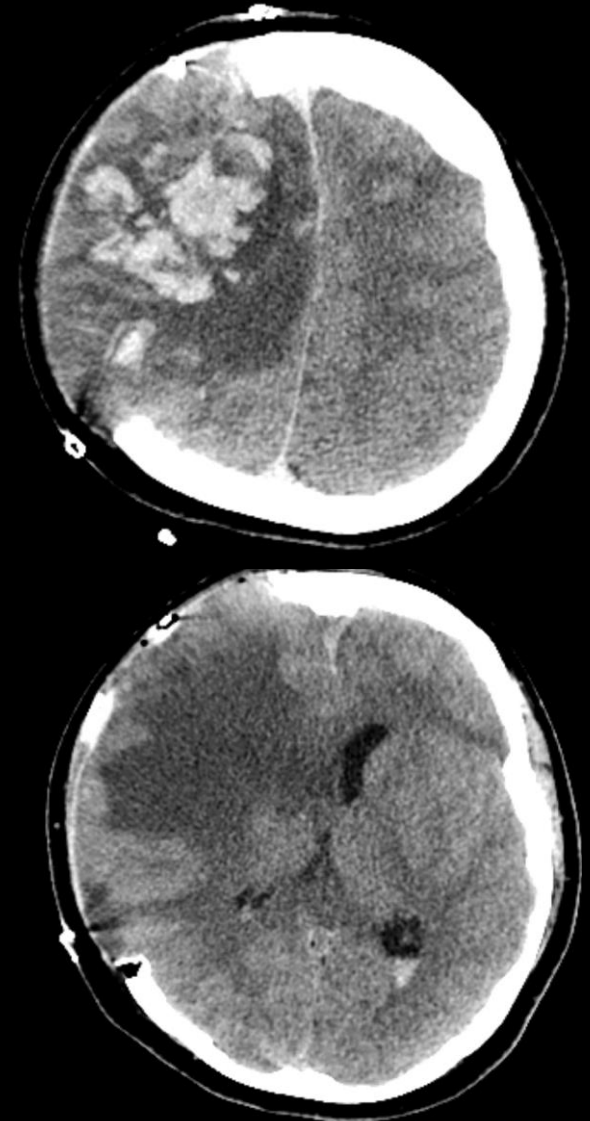
CEREBRAL VENOUS THROMBOSIS

TREATMENT

- Symptomatic treatment
- Anticoagulation
- Catheter therapy

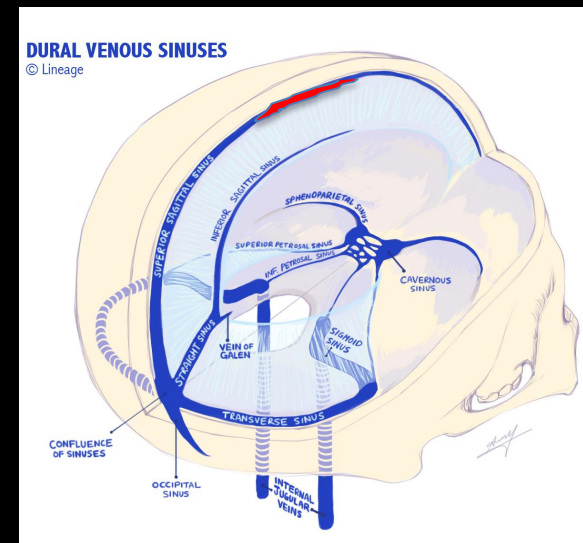
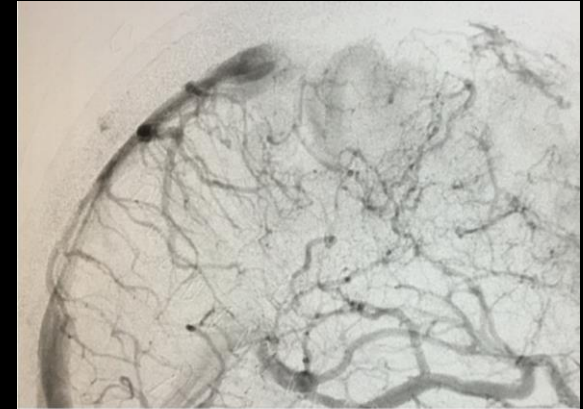
CEREBRAL VENOUS THROMBOSIS

- 44yo
- On OCP
- Developed headache which progressed to hemiparesis
- Admitted to OSH
- Diagnosed with SSS thrombosis
- Started on anticoagulation
- Called 2/2 worsening edema
- Hemicraniectomy with significant



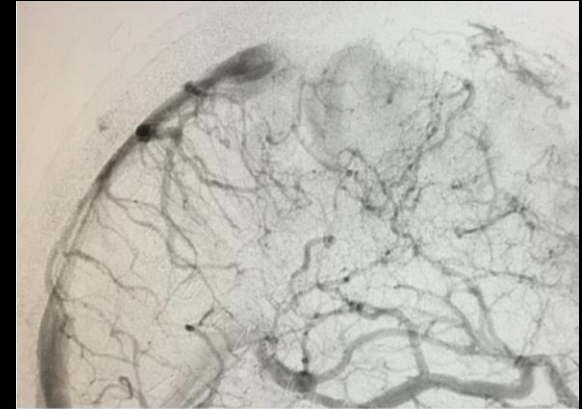
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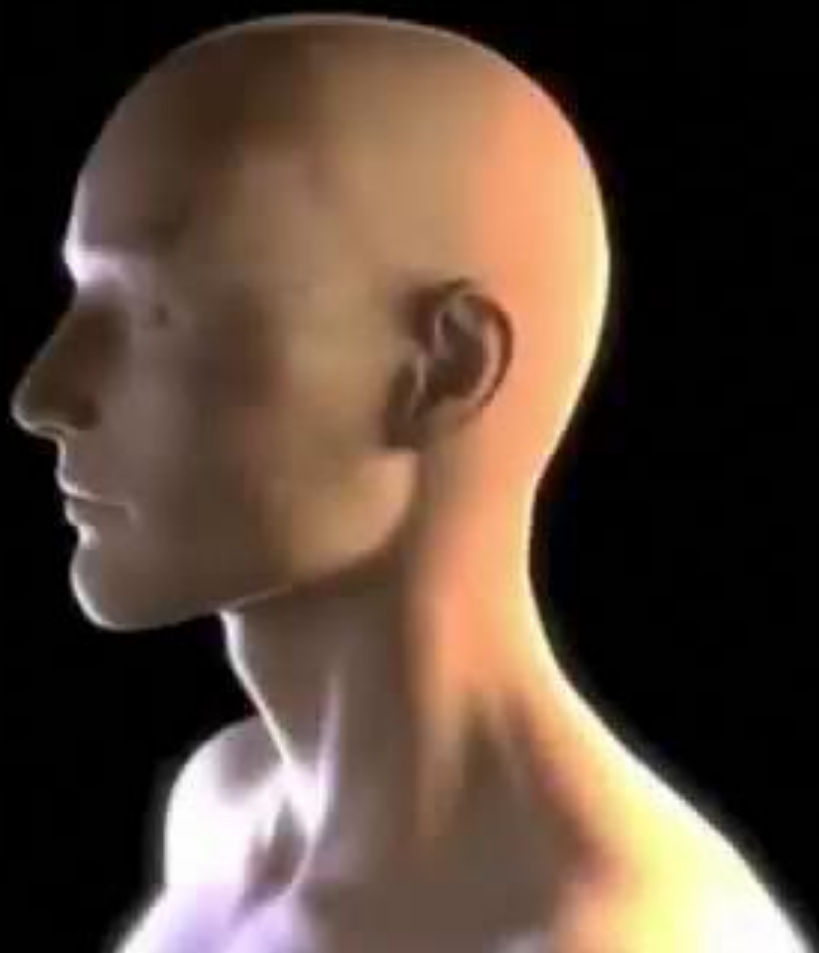


ARTERIAL STROKE

- Highest risk in post partum period
- Pregnancy specific causes
- Eclampsia
- Choriocarcinoma
- Amniotic fluid embolism
- Post partum angiopathy
- Post-partum cardiomyopathy



LARGE VESSEL OCCLUSION





Retriever with Balloon Guide (only)

2015

THE NEW ENGLAND JOURNAL OF MEDICINE

ORIGINAL ARTICLE

A Randomized Trial of Intraarterial Treatment for Acute Ischemic Stroke

O.A. Berkhemer, P.S.S. Fransen, D. Beumer, L.A. van den Berg, H.F. Lingsma, A.J. Yoo, W.J. Schonewille, J.A. Vos, J. Staals, J. Hofmeijer, J. P.A. Brouwer, B.J. Emmi, E.J. van Dijk, J. de Vries, B.A.A.M. van Hasselt, P.C. Vroomen, O. Eshq, A.V. Tielbeek, H.M. den H, E.W. Steyerberg, H.Z. Flad, L.F.M. Beenen, R. van den A. van der Lugt, R.J. van fo

THE NEW ENGLAND JOURNAL OF MEDICINE

ORIGINAL ARTICLE

Randomized Assessment of Rapid Endovascular Treatment of Ischemic Stroke

M. Goyal, A.M. Demchuk, B.K. Menon, M. Foca, I.I. Remmel, I. Thornton, D. Rov, T.G. Jovin, R.A. Willinsky, B.L. Sa, W.J. Montaner, A.Y. Poppe, K.J. D. Williams, O.Y. Bang, B.V. C.A. Holmstedt, B. Jankowitz, S.-I. Sohn, R.H. Swartz, P.A. B, A. Weill, S. Subramaniam, T.T. Sajobi, and M.D. Hi

THE NEW ENGLAND JOURNAL OF MEDICINE

ORIGINAL ARTICLE

Endovascular Therapy for Ischemic Stroke with Perfusion-Imaging Selection

B.C.V. Campbell, P.J. Mitchell, T.J. Kleinig, H.M. Dewey, L. Churilov, N. Yassi, B. Yan, R.J. Dowling, M.A. Simpson, F. Miteff, B.S. Steinfort, M. Prigling, T. Wijeratne, T.G. Phan, W. L. de Villiers, H. Ma, for th

ORIGINAL ARTICLE

Stent-Retriever Thrombectomy after Intravenous t-PA vs. t-PA Alone in Stroke

Jeffrey L. Saver, M.D., Mayank Goyal, M.D., Alain Bonafe, M.D., Hans-Christoph Diener, M.D., Ph.D., Elad I. Levy, M.D., Vitor M. Pereira, M.D., Gregory W. Albers, M.D., Christophe Cognard, M.D., David J. Cohen, M.D., Werner Hacke, M.D., Ph.D., Olav Jansen, M.D., Ph.D., Tudor G. Jovin, M.D., Heinrich P. Mattle, M.D., Raul G. Nogueira, M.D., Dileep R. Yavagal, M.D., Blaise W. Baxter, M.D., Demetrius K. Lopes, M.D., Vivek K. Reddy, M.D., R. Oliver C. Singer, M.D., and Reza Jahan, M.D., f

THE NEW ENGLAND JOURNAL OF MEDICINE

ORIGINAL ARTICLE

Thrombectomy within 8 Hours after Symptom Onset in Ischemic Stroke

T.G. Jovin, A. Chamorro, E. Cobo, M.A. de Miquel, C.A. Molina, A. Rovira, L. San Román, J. Serena, S. Abilleira, M. Ribó, M. Millán, X. Urra, P. Cardona, E. López-Cancio, A. Tomasello, C. Castaño, J. Blasco, L. Aja, L. Dorado, H. Quesada, M. Rubiera, M. Hernández-Pérez, M. Goyal, A.M. Demchuk, R. von Kummer, M. Gallofré, and A. Dávalos, for the REVASCAT Trial Investigators*

MR CLEAN

ESCAPE

EXTEND-IA

SWIFT PRIME

REVASCAT

2015

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ORIGINAL ARTICLE

A Randomized Trial of Intraarterial Treatment for Acute Ischemic Stroke

O.A. Berkhemer, P.S.S. Fransen, D. Beumer, L.A. van den Berg, H.F. Lingsma, A.J. Yoo, W.J. Schonewille, J.A. Vos, J. Staals, J. Hofmeier, J.

THE NEW ENGLAND JOURNAL of MEDICINE

MR CLEAN

2015 AHA/ASA Focused Update of the 2013 Guidelines for the Early Management of Patients with Acute Ischemic Stroke Regarding Endovascular Treatment

SW



Together to End Stroke™

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NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Thrombectomy within 8 Hours after Symptom Onset in Ischemic Stroke

T.G. Jovin, A. Chamorro, E. Cobo, M.A. de Miquel, C.A. Molina, A. Rovira, L. San Román, J. Serena, S. Abilleira, M. Ribó, M. Millán, X. Urra, P. Cardona, E. López-Cancio, A. Tomasello, C. Castaño, J. Blasco, L. Alcazar, J. Dorado, H. Quesada, M. Rubiera, M. Hernández-Pérez, M. G. R. von Kummer, M. Gallofré, and A. Dávalos, for the REVA

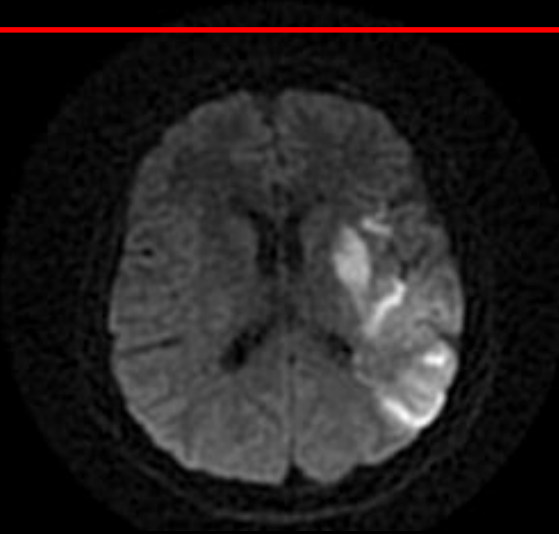
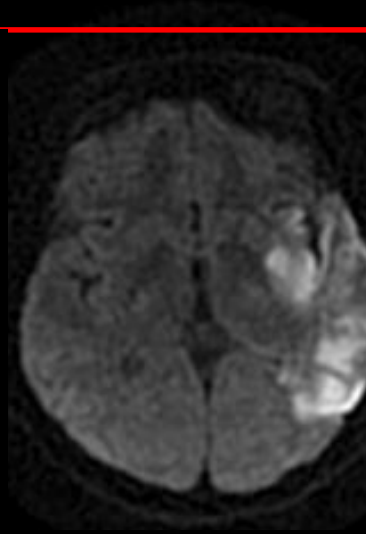


REVASCAT

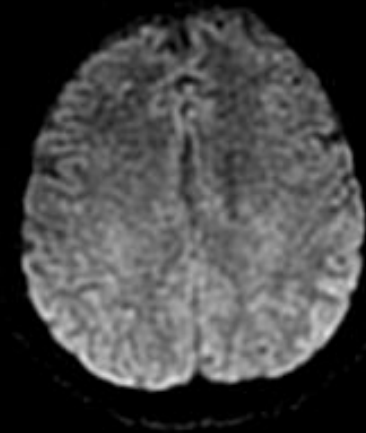
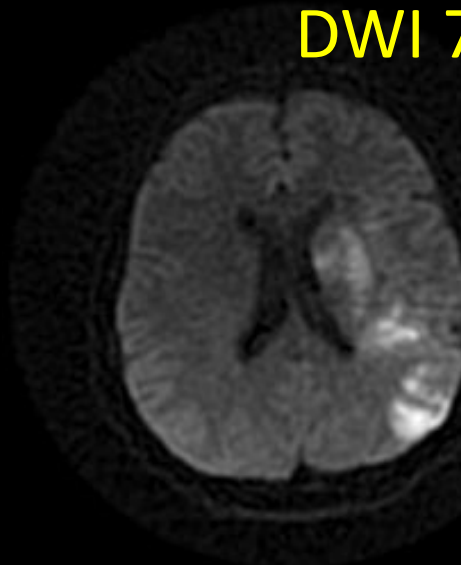
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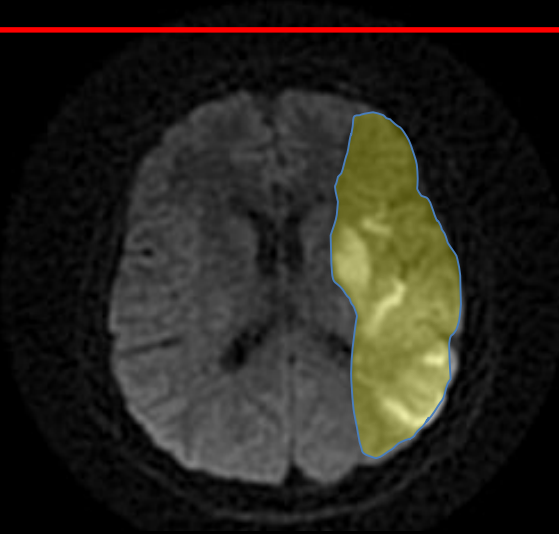
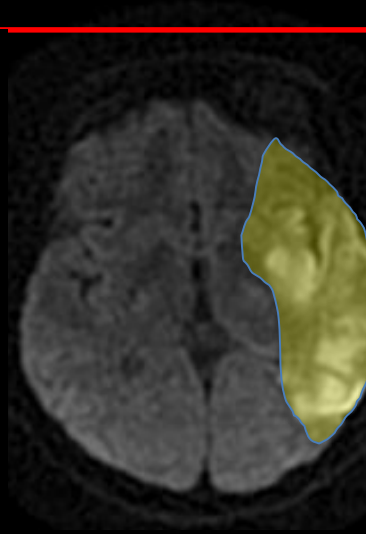
39 yo 2 months pregnant, with acute onset of right weakness, left gaze, and aphasia upon awakening at 4pm. Last known well unknown. OSH: DWI: infarct in left basal ganglia and temp lobe. On arrival at MSNC patient has NIHSS of 17



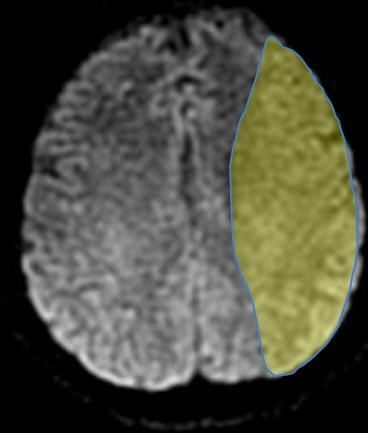
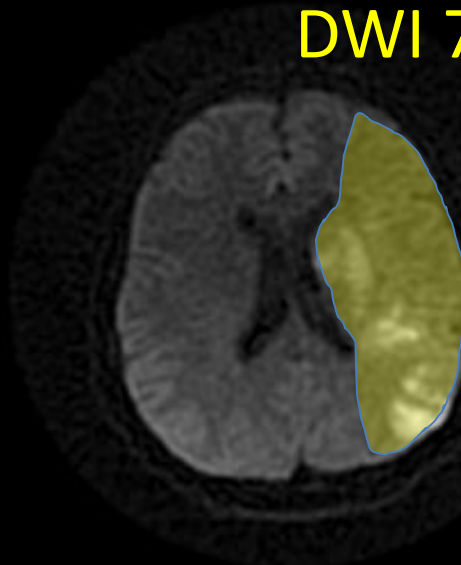
DWI 7:02PM



39 yo 2 months pregnant, with acute onset of right hemiplegia, left gaze, and aphasia upon awakening at 4pm. Last known well unknown. OSH: DWI: infarct in left basal ganglia and temp lobe. On arrival at MSNC patient has NIHSS of 17

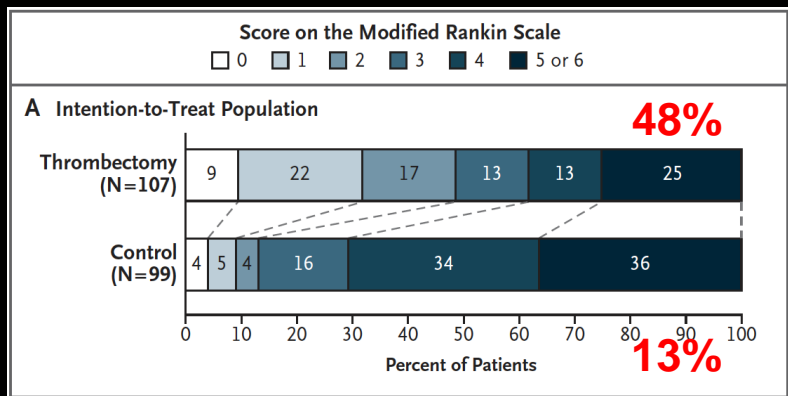
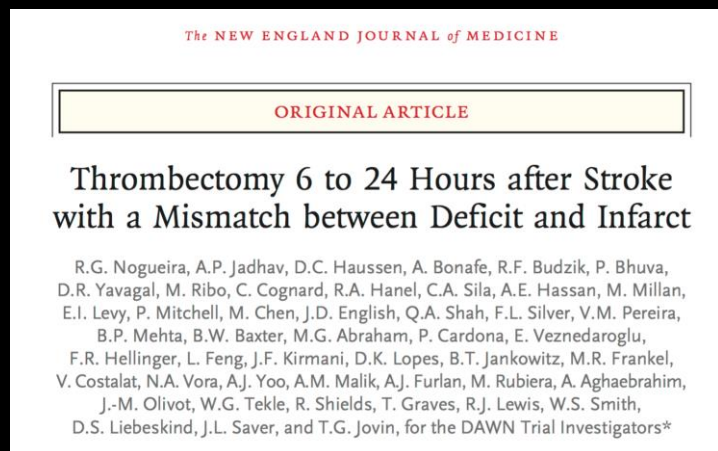


DWI 7:02PM



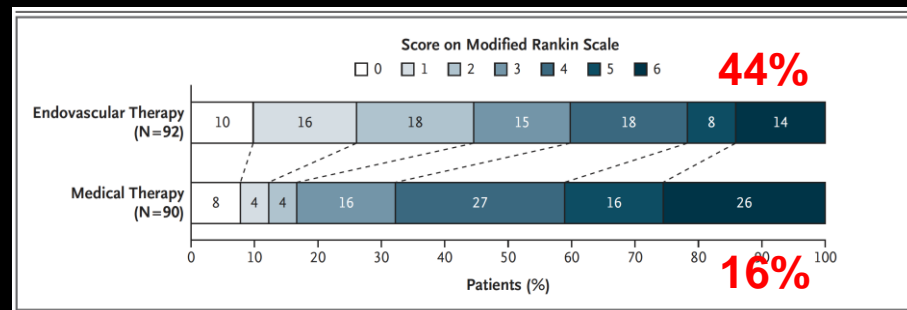
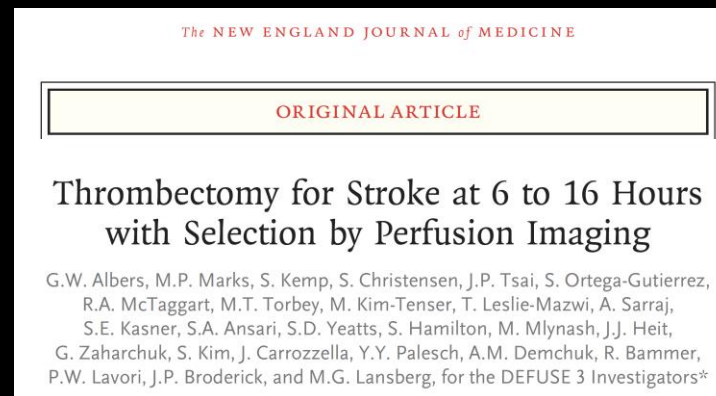
2018 - EXTENDED WINDOW

DAWN

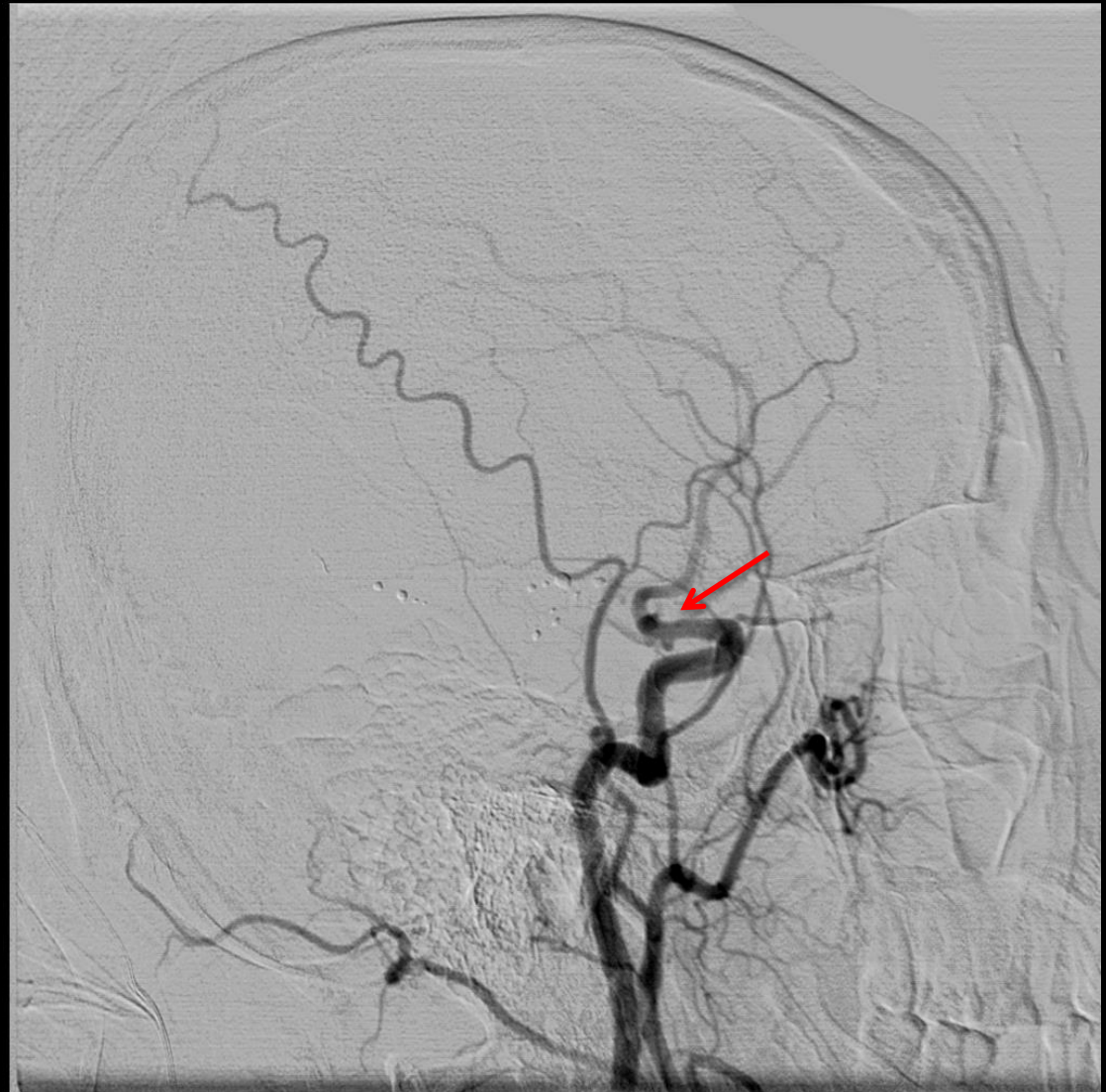


NNT for 90-day independence = 2.8

DEFUSE 3



Arterial Access 22:35 - Left M1 Occlusion



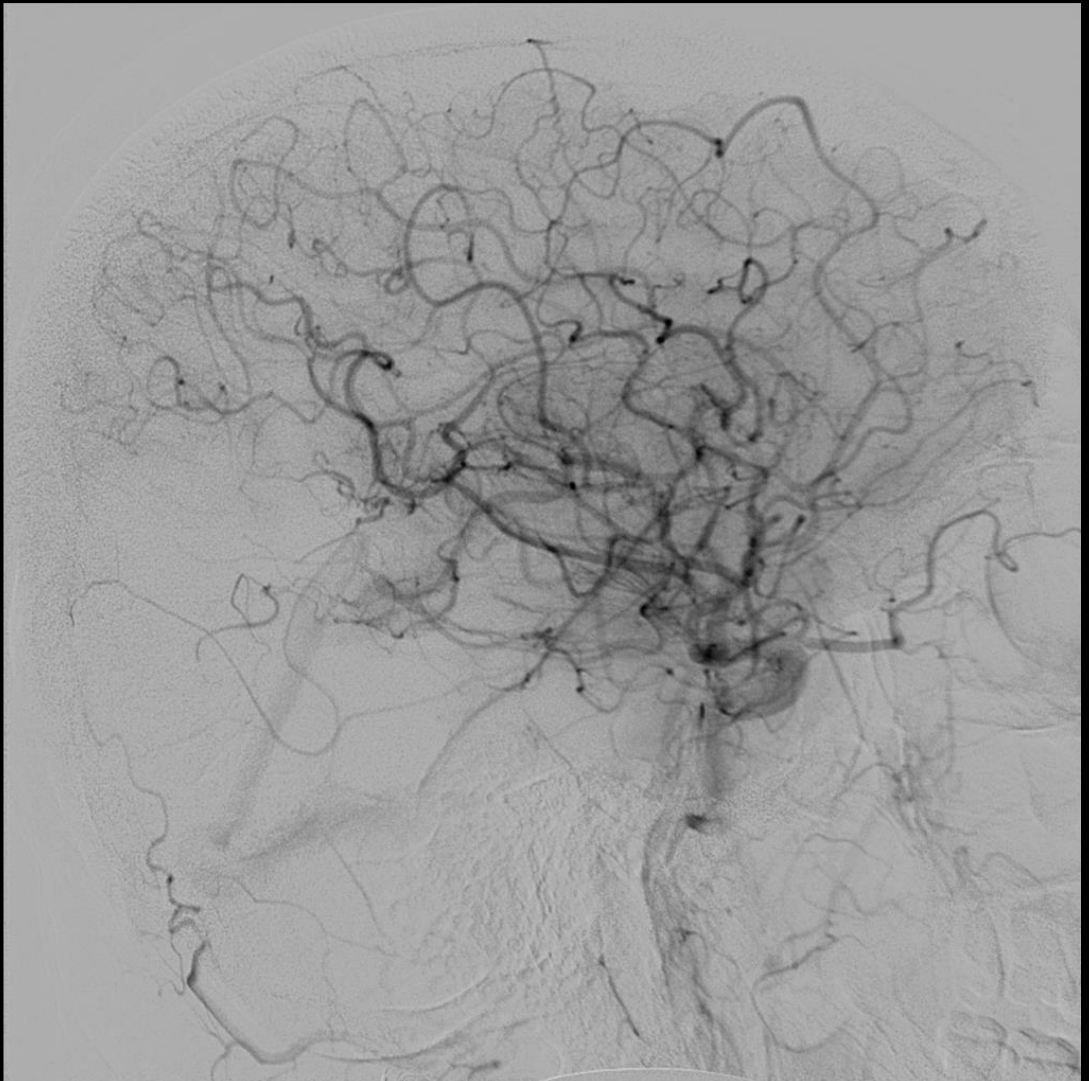
Post Trevo 4x20: Residual Distal M2-M3 Occlusion



Baby Trevo (3x20) in M2-M3

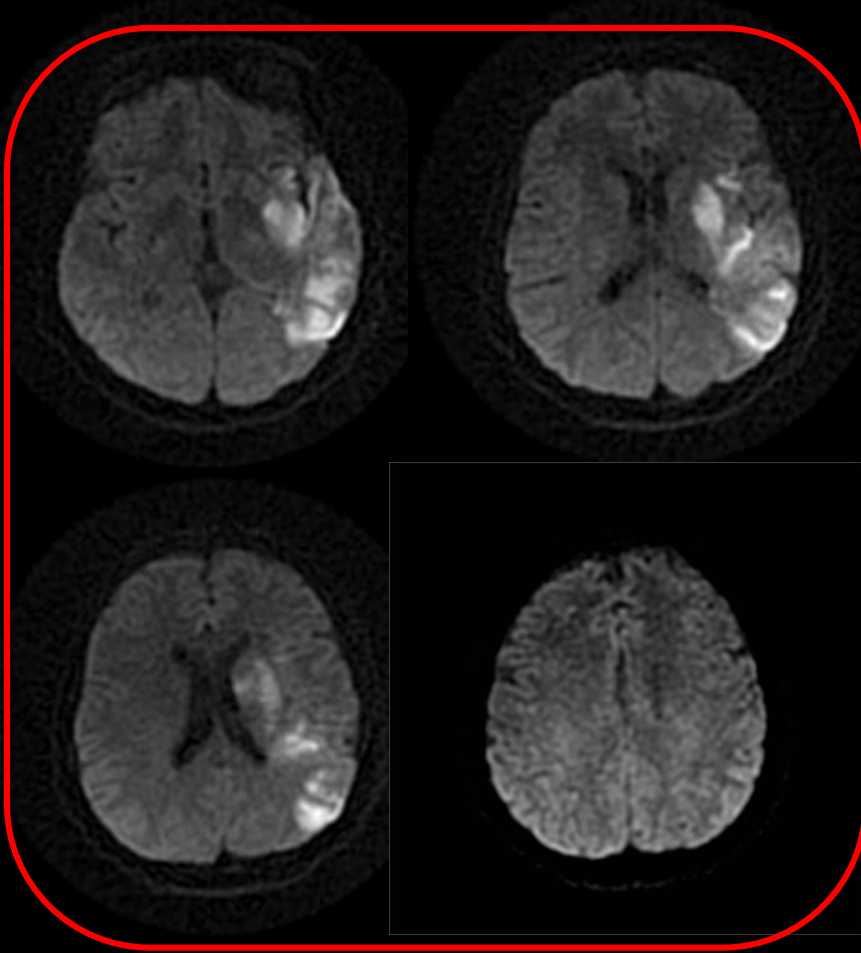


TICI 2B but Full Reperfusion of the Target Territory

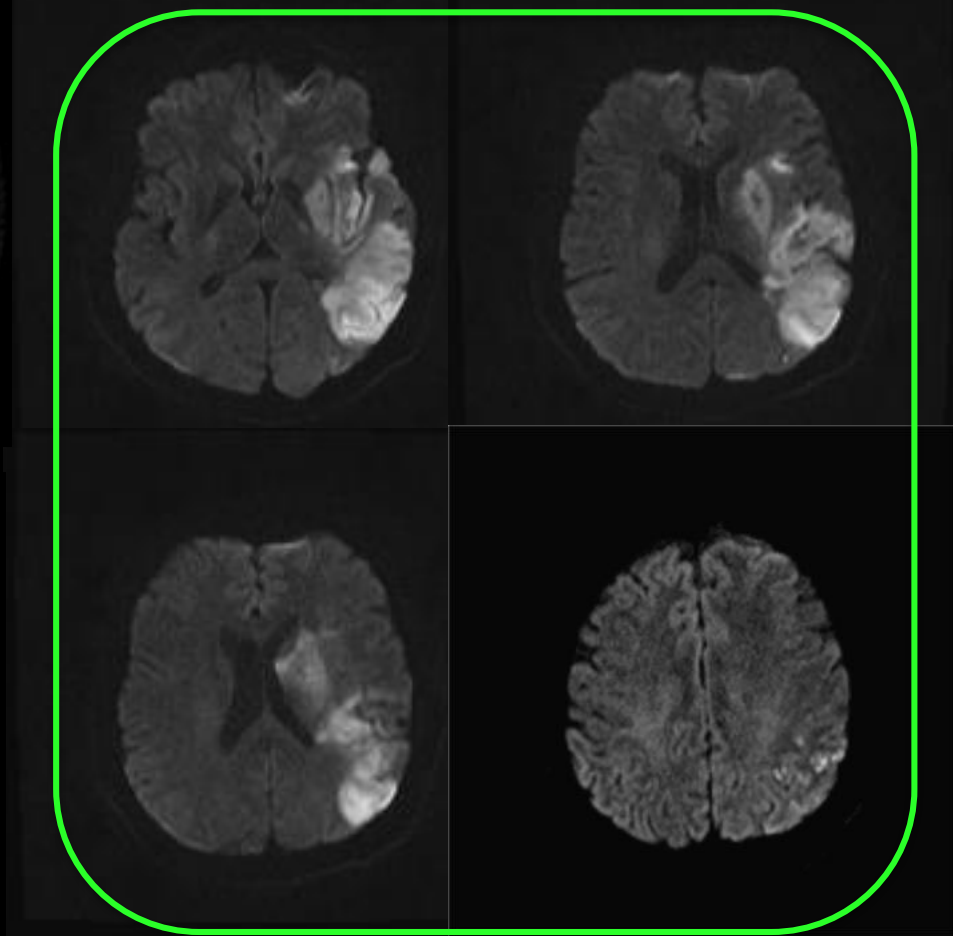


Penumbral Area Completed Spared

Pre-Treatment DWI



Post-Treatment DWI



She was able to hold her baby!



STROKE AND PREGNANCY

- US: incidence of stroke in pregnancy is increasing.
 - Nationwide Inpatient Sample
 - Between 1994–1995 to 2006–2007,
 - Rates of antenatal and postpartum hospitalizations for stroke increased by 47% and 83%, respectively.

Kuklina et al. 2011

STROKE AND PREGNANCY

- Women with concomitant diagnoses of hypertension and heart disease are more likely to also be diagnosed with a stroke of any type.
- This association was so strong, that when the authors corrected for hypertension and heart disease in a logistic regression model, the increase in stroke rates from 1994–1995 to 2006–2007 dissipated.

Kuklina et al. 2011

CONCLUSIONS

- Prenatal care / Primary Care : Critical to improve maternal outcomes
- When strokes occur (hemorrhage from aneurysm or malformation / infarct from arterial or venous disease) can be treated in comprehensive stroke centers

THANK YOU

NEUROINTERVENTION

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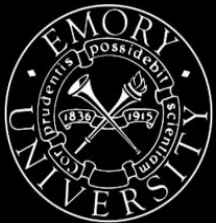
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